FANUC MANUAL GUIDE *i*

SET-UP GUIDANCE FUNCTIONS

OPERATOR'S MANUAL

B-63874EN-1/08

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In this manual we have tried as much as possible to describe all the various matters.
However, we cannot describe all the matters which must not be done, or which cannot be done, because there are so many possibilities.
Therefore, matters which are not especially described as possible in this manual should be regarded as "impossible".

This manual contains the program names or device names of other companies, some of which are registered trademarks of respective owners. However, these names are not followed by ® or ™ in the main body.

DEFINITION OF WARNING, CAUTION, AND NOTE

This manual includes safety precautions for protecting the user and preventing damage to the machine. Precautions are classified into Warning and Caution according to the degree of the risk or the severity of damage.
Also, supplementary information is described as Note.
Read the Warning, Caution, and Note thoroughly before attempting to use the machine.

⚠ WARNING

Applied when there is a danger of the user being injured or when there is a damage of both the user being injured and the equipment being damaged if the approved procedure is not observed.

⚠ CAUTION

Applied when there is a danger of the equipment being damaged, if the approved procedure is not observed.

NOTE

The Note is used to indicate supplementary information other than Warning and Caution.

- Read this manual carefully, and store it in a safe place.

PREFACE

To use the set-up guidance functions with MANUAL GUIDE *i*, the following preparations need to be made:

(1) The set-up guidance options are required.
(2) To operate the set-up guidance functions, probes, touch sensors, and other measuring instruments are required. For details, refer to the manual published by the machine tool builder.
(3) The measuring functions of MANUAL GUIDE *i* are implemented using the G31 command. Accordingly, the skip function (skip signal) or high-speed skip function (high-speed skip signal) of the CNC is required.
(4) To operate the set-up guidance functions, the machine tool builder needs to set required parameters beforehand. For details, see Appendix A.1, "REQUIRED PARAMETERS."
(5) To use the manual measurement functions, the machine tool builder needs to incorporate required processing into a PMC ladder program. For details, see Appendix C.1.1, "Setting for Operating Manual Measurement."
(6) To execute a measurement, measurement conditions such as a feedrate and the amount of movement for measurement, and calibration data such as a probe figure need to be set on the setting screen beforehand. For details, see Chapter 5, "MEASUREMENT SETTING SCREENS."
(7) To use the set-up guidance functions on machining center, tool offset memory B or tool offset memory C are required.

For the basic operations of MANUAL GUIDE *i*, refer to "MANUAL GUIDE *i* OPERATOR'S MANUAL (Common to Lathe System/Machining Center System) (B-63874EN)" or "MANUAL GUIDE *i* OPERATOR'S MANUAL (For Machining Center System) (B-63874EN-2)."

Related manuals

- Manuals related to MANUAL GUIDE *i*

The table below lists manuals related to MANUAL GUIDE *i*.

Manual name	Specification Number	
OPERATOR’S MANUAL (Common to Lathe System/Machining Center System)	B-63874EN	
OPERATOR’S MANUAL (For Machining Center System)	B-63874EN-2	
OPERATOR’S MANUAL (SET-UP GUIDANCE FUNCTIONS)	B-63874EN-1	*

(*) In the table, this manual is marked with an asterisk (*).

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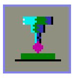
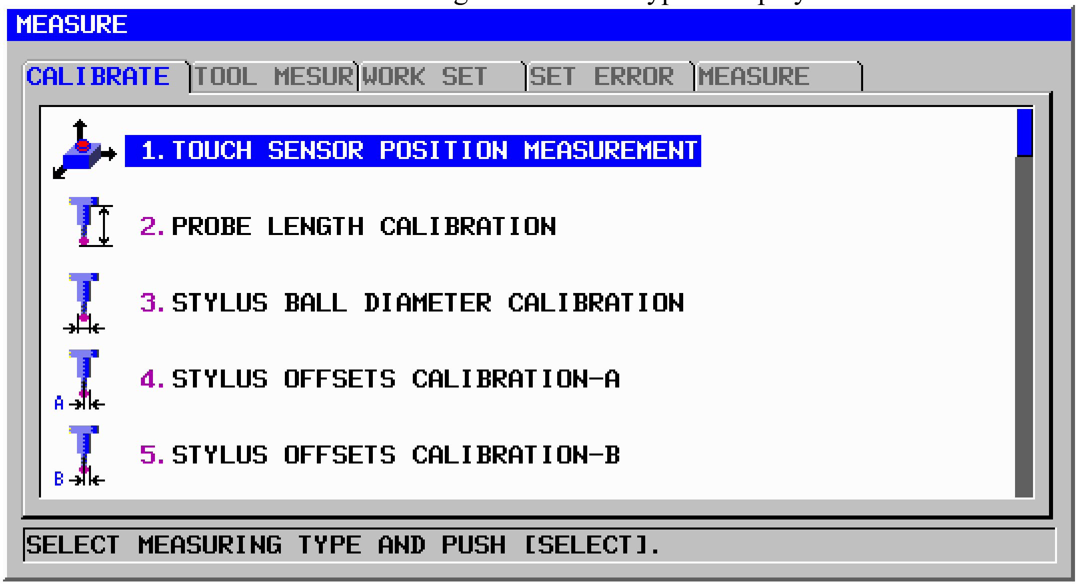
APPENDIX

I. SET-UP GUIDANCE FUNCTION

1 MANUAL MEASUREMENT FUNCTIONS

1.1 MEASUREMENT MENU SCREEN DISPLAY METHOD

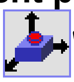
<1> Press the  [MESURE] soft key on the base screen in the manual operation mode. The measurement menu screen for selecting measurement type is displayed.



1.2 CALIBRATION

1.2.1 Touch Sensor Position Measurement

Measurement procedure

<1> Select  "TOUCH SENSOR POSITION MEASUREMENT" on the [CALIBRATE] tab of the measurement menu screen. The [TOUCH SENSOR POSITION MEASUREMENT] screen appears.

<2> Get the reference tool close to the touch sensor by moving it manually.

> **NOTE**
> Place the reference tool in such a safe place that when measurement is performed, that is, the tool touches the touch sensor, it will not touch the workpiece or machine.

<3> Select "MEASURE DIRECTION" from the [+X], [-X], [+Y], [-Y], [+Z], and [-Z] soft keys
<4> In "MEASURE CONDITION," select a measurement condition.
<5> Enter the reference tool dimensions in "REFERENCE TOOL LENGTH" and "REFERENCE TOOL X-OFFSET."
<6> Press the [MESURE] soft key. The probe touches the reference workpiece automatically, and the current position of the measurement point is displayed as the measurement result.
<7> Press the [→] cursor key. Select the [SET] tab.
<8> Specify a condition for which the measurement result is to be set by selecting it from the two or more "MEASURE CONDITION" items, using a number.

The number corresponding to the measurement condition specified on the "MEASURE" tab is displayed as initial value.
This "MEASURE CONDITION" is referenced at tool measurement.

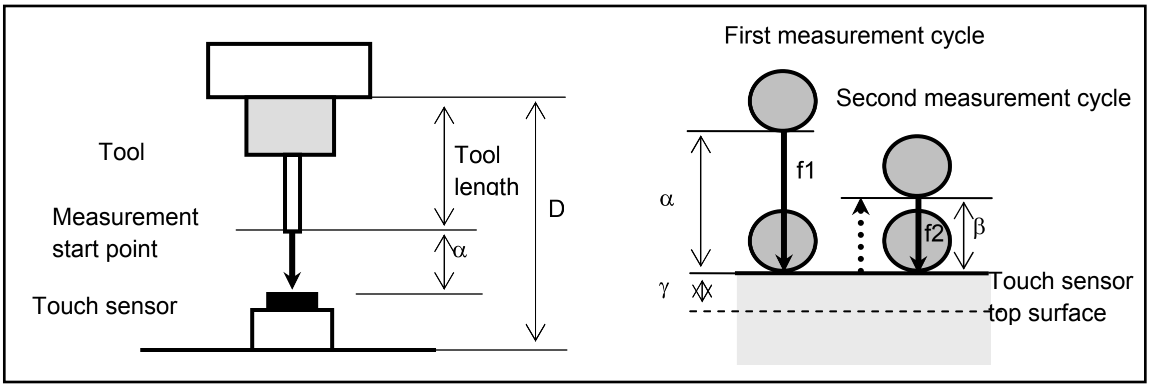
<9> When the "MEASURE CONDITION" is selected for the item for which the measurement result is to be set, the value set up as the current touch sensor position for the measurement condition is displayed.

<10>In "SET AXIS," select the coordinate axis for which the measurement result is to be set from the soft keys.
If the [ALL-AX] soft key is selected, the measurement positions on the X, Y, and Z3 axes are set as the position of the touch sensor of calibration data simultaneously when the [SETING] soft key is pressed.

<11>After entering the necessary data, press the [SET] soft key. The measurement result is set up as the measurement preparation data.

Measurement

Measurements are made as follows:



Meaning	Symbol in the explanation
Feedrate for 1st measurement	f1
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Feedrate for 2nd measurement	f2
Escaping distance for 2nd measurement	ε

<1> Get the tool close to the touch sensor by moving it manually.

<2> Within the range (α + γ) from the measurement start point, the tool moves at a feedrate of f1 to perform the first measurement cycle.

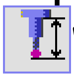
<3> Then, the tool returns through the distance β at the rapid traverse rate. Within the range (β + γ) from the current position, the tool moves at a specified feedrate of f2 to perform the second measurement cycle.

<4> After the second measurement cycle, the tool returns through the distance ε at the rapid traverse rate.

NOTE
The values of α, β, γ, ε, f1, f2 are specified in the MEASURE CONDITION OF TOOL MEASUREMENT window. Refer to section 3.1.2 of this manual.

1.2.2 Probe Length Calibration

Measurement procedure

<1> Select  "PROBE LENGTH CALIBRATION" on the [CALIBRATE] tab of the measurement menu screen. The [PROBE LENGTH CALIBRATION] screen appears.

<2> Get the probe close to the measurement reference workpiece such as a ring gauge by moving it manually.

> **NOTE**
> Place the probe in such a safe place that when measurement is performed, that is, the probe touches the reference workpiece, the probe will not touch the workpiece or machine.

<3> After moving the probe, select a measure direction from the [-X] and [-Z] soft keys.

<4> In "MEASURE CONDITION," select a measure condition.

<5> Enter the height of the measurement reference workpiece in "REFERENCE WORK HEIGHT."

<6> Press the [MESURE] soft key. The probe touches the reference workpiece automatically, and the current position of the measurement point is displayed as the measurement result.

<7> Press the [→] cursor key. Select the [SET] tab.

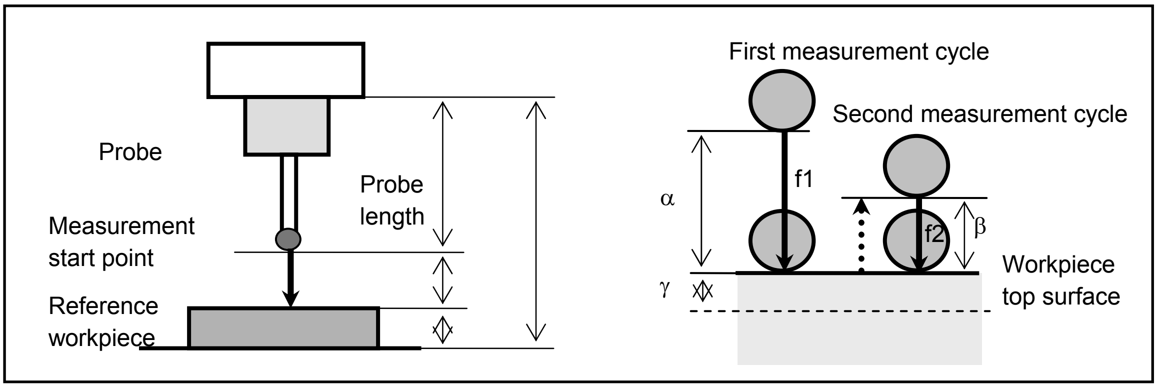
<8> Specify a condition for which the measurement result is to be set by selecting it from the two or more "MEASURE CONDITION" items, using a number.
The number corresponding to the measurement condition specified on the "MEASURE" tab is displayed as initial value.
This "MEASURE CONDITION" is referenced at workpiece measurement.

<9> Select the "MEASURE CONDITION" for the item to which the measurement result is to be set. The currently set value for the probe length for the measurement condition appears.

<10>After selecting the measurement condition, press the [SET] soft key. The measurement result is set as the measurement preparation data.

Measurement

Measurements are made as follows:



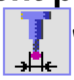
Meaning	Symbol in the explanation
Feedrate for 1st measurement	f1
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Feedrate for 2nd measurement	f2
Escaping distance for 2nd measurement	ε

<1> Get the probe close to the top surface of the reference workpiece by moving it manually.
<2> Within the range ($\alpha + \gamma$) from the measurement start point, the probe moves at a feedrate of f1 to perform the first measurement cycle.
<3> Then, the probe returns through the distance β at the rapid traverse rate. Within the range ($\beta + \gamma$) from the current position, the probe moves at a specified feedrate of f2 to perform the second measurement cycle.
<4> After the second measurement cycle, the probe returns through the distance ε at the rapid traverse rate.

NOTE
The values of α, β, γ, ε, f1, f2 are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

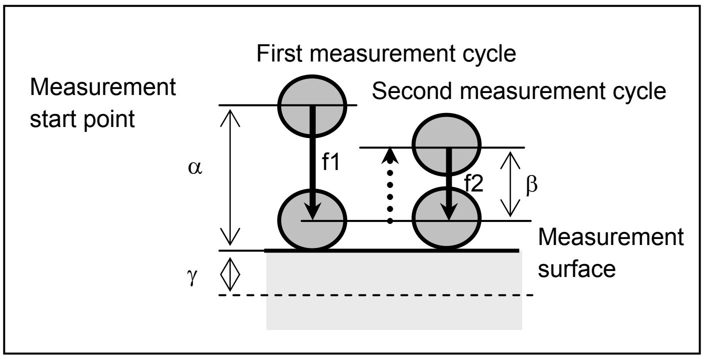
1.2.3 Stylus Ball Diameter Calibration

Measurement procedure

<1> Select  "STYLUS BALL DIAMETER CALIBRATION" on the [CALIBRATE] tab of the measurement menu screen. The [STYLUS BALL DIAMETER CALIBRATION] screen appears.
<2> Enter the diameter of the measurement reference workpiece in "REFERENCE WORK DIAMETER."
<3> Press the [→] cursor key. The "MEASURE" screen appears.
<4> In "MEASURE DIRECTION," select a measurement plane from the [X-Y] and [Y-Z] soft keys.
The subsequent input item name, input value, and measurement result axis address vary depending on what plane was selected. (See "OUTSIDE DIAMETER MEASUREMENT" in "WORK SET" for details.)
<5> In "MEASURE CONDITION," select a measure condition.
<6> Place the probe in the first measurement start position for the measurement reference workpiece such as a ring gauge by moving it manually.
<7> In "1ST PT. MEASURE DIRECT," select a measurement direction from the soft keys.
<8> Press the [MESURE] soft key. The probe touches the reference workpiece automatically, and the current position of the measurement point is displayed as the measurement result.
<9> Perform measurement for the second, third, and fourth points in the same manner as for the first point.
<10>Press the [→] cursor key. Select the [SET] tab.
<11>Using a number, specify a condition for which the measurement result is to be set by selecting it from the two or more "MEASURE CONDITION" items.
The number corresponding to the measurement condition specified on the "MEASURE" tab is displayed as initial value.
This "MASURE CONDITION" is referenced at workpiece measurement.
<12>Select the "MEASURE CONDITION" for the item to which the measurement result is to be set. The currently set value for the stylus ball diameter for the measurement condition appears.
<13>After making a measurement condition selection, press the [SETING] soft key. The result of measurement is set as calibration data.

Measurement

Measurements are made as follows:



Meaning	Symbol in the explanation
Feedrate for 1st measurement	f1
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Feedrate for 2nd measurement	f2
Escaping distance for 2nd measurement	ε

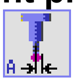
<1> Get the probe close to the measurement position by moving it manually.
<2> When measurement is started, the probe moves at a feedrate of f1 in the range (α + γ) from the current position to perform the first measurement cycle.
<3> Then, the probe returns through the distance β at the rapid traverse rate. Within the range (β + γ) from the current position, the probe moves at a feedrate of f2 to perform the second measurement cycle.
<4> The probe returns through the distance ε at the rapid traverse rate.

> **NOTE**
> The values of α, β, γ, ε, f1, f2 are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

1.2.4 Stylus Offsets Calibration-A

(*) The spindle orientation function is used for this function.

Measurement procedure

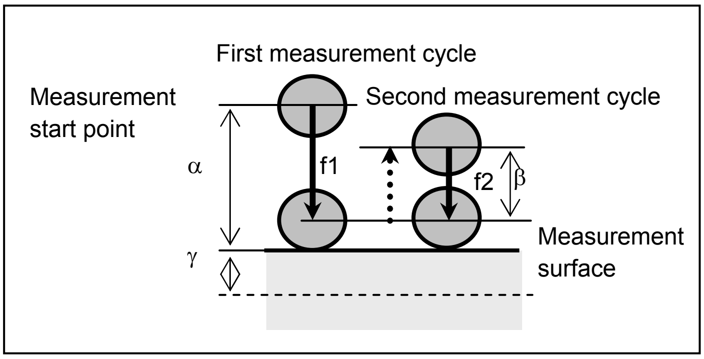
<1> Select  "STYLUS OFFSETS CALIBRATION-A" on the [CALIBRATE] tab of the measurement menu screen. The [STYLUS OFFSETS CALIBRATION-A] screen appears.
<2> Enter the diameter of the measurement reference workpiece in "REFERENCE WORK DIAMETER."
<3> Press the [→] cursor key. The "MEASURE" screen appears.

> **NOTE**
> The same measurement procedure as for "STYLUS BALL DIAMETER CALIBRATION" applies to "STYLUS OFFSETS CALIBRATION-A."
> See "STYLUS BALL DIAMETER CALIBRATION" for details.

<4> Press the [→] cursor key. Select the [SET] tab.
<5> Specify a condition for which the measurement result is to be set by selecting it from the two or more "MEASURE CONDITION" items, using a number.
The number corresponding to the measurement condition specified on the "MEASURE" tab is displayed as initial value.
This "MEASURE CONDITION" is referenced at workpiece measurement.
<6> When the "MEASURE CONDITION" is selected for the item for which the measurement result is to be set, the value set up as the current stylus ball center offset for the measurement condition is displayed.
<7> After making a measurement condition selection, press the [SETING] soft key. The result of measurement is set as calibration data.

Measurement

Measurements are made as follows:



Meaning	Symbol in the explanation
Feedrate for 1st measurement	f1
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Feedrate for 2nd measurement	f2
Escaping distance for 2nd measurement	ε

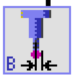
<1> Get the probe close to the measurement position by moving it manually.
<2> When measurement is started, the probe moves at a feedrate of f1 in the range (α + γ) from the current position to perform the first measurement cycle.
<3> Then, the probe returns through the distance β at the rapid traverse rate. Within the range (β + γ) from current position, the probe moves at a feedrate of f2 to perform the second measurement cycle.
<4> The probe returns again through the distance β at the rapid traverse speed to perform 180° spindle orientation.
<5> Within the range (β + γ) from the current position, the probe moves at a feedrate of f2 to perform the third measurement cycle.
<6> After the third measurement cycle, the probe returns through the distance ε at the rapid traverse rate.
<7> Again, 0° spindle orientation is performed.

NOTE
The values of α, β, γ, ε, f1, f2 are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

1.2.5 Stylus Offsets Calibration-B

> **NOTE**
> The center of a reference workpiece such as a ring gauge needs to be placed accurately at a table position whose machine coordinates are known.

Measurement procedure

<1> Select  "STYLUS OFFSETS CALIBRATION-B" on the [CALIBRATE] tab of the measurement menu screen. The [STYLUS OFFSETS CALIBRATION-B] screen appears.

<2> Enter the coordinates of the center position of the measurement reference workpiece in "CENTER COORDINATE."
Use the coordinates in the machine coordinate system to specify the position.

<3> Press the [→] cursor key. The "MEASURE" screen appears.

> **NOTE**
> The same measurement procedure as for "STYLUS BALL DIAMETER CALIBRATION" applies to "STYLUS OFFSETS CALIBRATION-B."
> See "STYLUS BALL DIAMETER CALIBRATION" for details.

<4> Press the [→] cursor key. Select the [SET] tab.

<5> Using a number, specify a condition for which the measurement result is to be set by selecting it from the two or more "MEASURE CONDITION" items.
The number corresponding to the measurement condition specified on the "MEASURE" tab is displayed as initial value.
This "MEASURE CONDITION" is referenced at workpiece measurement.

<6> When the "MEASURE CONDITION" is selected for the item for which the measurement result is to be set, the value set up as the current stylus ball center offset for the measurement condition is displayed.

<7> After making a measurement condition selection, press the [SETING] soft key. The result of measurement is set as calibration data.

Measurement

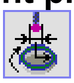
> **NOTE**
> The same measurement procedure as for STYLUS BALL DIAMETER CALIBRATION applies to "STYLUS OFFSETS CALIBRATION-B."
> See "STYLUS BALL DIAMETER CALIBRATION" for details.

1.2.6 Stylus Ball Diameter Calibration (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the diameter of the stylus ball is obtained from the average of the results.

> **NOTE**
> This function is enabled when bit 1 (RST) of parameter No. 27222 is set to 1.

Measurement procedure

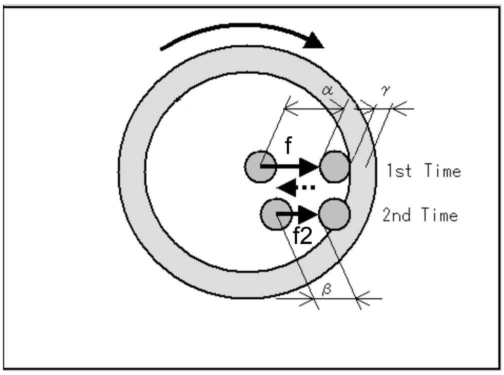
<1> Select  "STYLUS BALL DIAMETER CALIBRATION-WORK ROTATION" on the [CALIBRATE] tab of the measurement menu screen.

<2> The [ORIGIN] tab screen appears. On this screen, enter the diameter of a reference workpiece. Moreover, enter "CENTER PT.(1ST AXIS)" and "CENTER PT.(2ND AXIS)" as values in the workpiece coordinate system.
<3> After entering data, press the [→] cursor key. The [MEASURE] tab screen appears. In "MEASURE PLANE," select a measurement plane from the soft keys.
<4> In "MEASURE DIRECTION," select a measurement direction from the soft keys.
<5> In "MEASURE CONDITION," enter a measurement condition by specifying a numeric value.
<6> In "MEASURE ANGLE," enter a measurement angle by specifying a numeric value.
<7> After moving the probe manually to the measurement start position, enter data then press the [MESURE] soft key. A measurement is started. Upon completion of measurement, the screen displays the result of measurement.
<8> The same procedure is applicable to "2ND PT. MEASURE ANGLE," "3RD PT. MEASURE ANGLE," and "4TH PT. MEASURE ANGLE."
<9> Press the [→] cursor key. The [SET] tab screen appears. On this screen, set the diameter of the stylus ball calculated from the result of measurement, as calibration data.
This screen displays the same information and operation procedure as for the conventional "STYLUS BALL DIAMETER CALIBRATION." However, the result of measurement indicates only the resultant diameter value in the measurement direction.

Measurement

- When rotation axis positioning based on C-axis rotation is used (when bit 2 (CMV) of parameter No. 27223 is set to 1)

A measurement operation with the +X direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified in "MEASURE ANGLE."
<2> A measurement is made in the range ($\alpha + \gamma$) at a feedrate of f (first measurement cycle).
<3> Next, the probe returns through the distance β at the rapid traverse rate then moves in the range ($\beta + \gamma$) at a feedrate of f2 from that position to make a measurement (second measurement cycle).
<4> The probe returns through the distance ε in the X-axis direction at the rapid traverse rate.

Meaning	Symbol in the explanation
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Feedrate for 2nd measurement	f2
Escaping distance for 2nd measurement	ε

> **NOTE**
> The values of α, β, γ, ε, f, f2 are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

- When rotation axis positioning based on the spindle orientation function is used (when bit 2 (CMV) of parameter No. 27223 is set to 0)

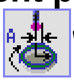
The procedure is the same as for outside diameter measurement (work rotation type).

1.2.7 Stylus Offsets Calibration-A (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the center offset of the stylus ball is obtained from the average of the results.

> **NOTE**
> This function is enabled when bit 1 (RST) of parameter No. 27222 is set to 1.

Measurement procedure

<1> Select  "STYLUS OFFSETS CALIBRATION-A-WORK ROTATION" on the [CALIBRATE] tab of the measurement menu screen. The [ORIGIN] tab screen appears. This screen displays the same information and operation procedure as for "STYLUS BALL DIAMETER CALIBRATION-WORK ROTATION."

<2> After entering data, press the [→] cursor key. The [MEASURE] tab screen appears. This screen displays the same information and operation procedure as for "STYLUS BALL DIAMETER CALIBRATION-WORK ROTATION."

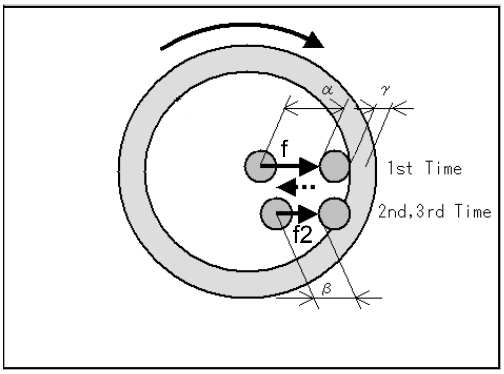
<3> After a measurement is made at each point, the result of measurement appears on the screen.

<4> Upon completion of measurement, press the [→] cursor key. The [SET] tab screen appears. On this screen, set the center offset of the stylus ball calculated from the result of measurement, as calibration data.
This screen displays the same information and operation procedure as for "STYLUS OFFSETS CALIBRATION-A." However, the result of measurement indicates only the resultant offset value in the measurement direction.

Measurement

- When rotation axis positioning based on C-axis rotation is used (when bit 2 (CMV) of parameter No. 27223 is set to 1)

A measurement operation with the +X direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified in "MEASURE ANGLE."

<2> The probe axis is oriented at the angle 0°.

<3> A measurement is made in the range (α + γ) at a feedrate of f (first measurement cycle).

<4> Next, the probe returns through the distance β at the rapid traverse rate then moves in the range (β + γ) at a feedrate of f2 from that position to make a measurement (second measurement cycle).
<5> Next, the probe returns through the distance β at the rapid traverse rate.
<6> The probe axis is oriented at the angle 180°.
<7> The probe moves in the range (β + γ) at a feedrate of f2 from that position to make a measurement (third measurement cycle).
<8> The probe returns through the distance ε in the X-axis direction at the rapid traverse rate.
<9> The probe axis is oriented at the angle 0°.

Meaning	Symbol in the explanation
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Feedrate for 2nd measurement	f2
Escaping distance for 2nd measurement	ε

NOTE
The values of α, β, γ, ε, f, f2 are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

- **When rotation axis positioning based on the spindle orientation function is used (when bit 2 (CMV) of parameter No. 27223 is set to 0)**

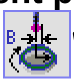
The procedure is the same as for outside diameter measurement (work rotation type).

1.2.8 Stylus Offsets Calibration-B (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the center offset of the stylus ball is obtained from the average of the results.

NOTE
This function is enabled when bit 1 (RST) of parameter No. 27222 is set to 1.

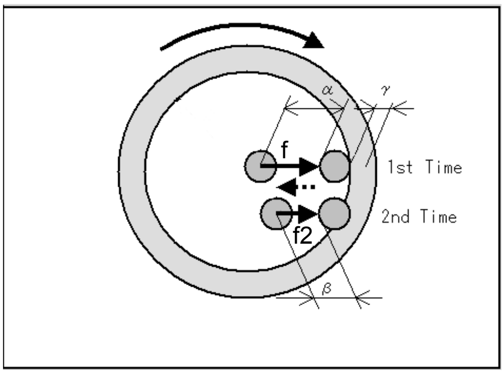
Measurement procedure

<1> Select  "STYLUS OFFSETS CALIBRATION-B-WORK ROTATION" on the [CALIBRATE] tab of the measurement menu screen. The [ORIGIN] tab screen appears. This screen displays the same information and operation procedure as for "STYLUS BALL DIAMETER CALIBRATION-WORK ROTATION."
<2> After entering data, press the [→] cursor key. The [MEASURE] tab screen appears. This screen displays the same information and operation procedure as for “STYLUS BALL DIAMETER CALIBRATION-WORK ROTATION.”
<3> After a measurement is made at each point, the result of measurement appears on the screen.
<4> Upon completion of measurement, press the [→] cursor key. The [SET] tab screen appears. On this screen, set the center offset of the stylus ball calculated from the result of measurement, as calibration data.
This screen displays the same information and operation procedure as for "STYLUS OFFSETS CALIBRATION-B." However, the result of measurement indicates only the resultant offset value in the measurement direction.

Measurement

- **When rotation axis positioning based on C-axis rotation is used (when bit 2 (CMV) of parameter No. 27223 is set to 1)**

A measurement operation with the +X direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified in "MEASURE ANGLE."
<2> A measurement is made in the range (α + γ) at a feedrate of f (first measurement cycle).
<3> Next, the probe returns through the distance β at the rapid traverse rate then moves in the range (β + γ) at a feedrate of f2 from that position to make a measurement (second measurement cycle).
<4> The probe returns through the distance ε in the X-axis direction at the rapid traverse rate.

Meaning	Symbol in the explanation
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Feedrate for 2nd measurement	f2
Escaping distance for 2nd measurement	ε

NOTE

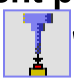
The values of α, β, γ, ε, f, f2 are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

- **When rotation axis positioning based on the spindle orientation function is used (when bit 2 (CMV) of parameter No. 27223 is set to 0)**

The procedure is the same as for outside diameter measurement (work rotation type).

1.3 TOOL MEASUREMENT

Measurement procedure

<1> Select  "TOOL MEASUREMENT" on the [TOOL MESUR] tab of the measurement menu screen. The [TOOL MEASUREMENT] screen appears.
<2> If a tool to be measured is already selected, select the [MEASURE] tab. In this case, proceed to step <7>.
<3> Place the spindle in a place where it is safe to exchange the tool.
<4> After entering the tool number for which measurements are to be made, press the [INPUT] key.
<5> Press the [TL-SEL]soft key. The specified tool is selected.
<6> Upon completion of tool indexing, select the [MEASURE] tab by pressing the [→] cursor key.
<7> Get the tool close to the touch sensor by moving it manually.

> **NOTE**
> Place the tool in such a safe place that when measurement is performed, that is, the tool touches the touch sensor, the measurement tool will not touch the workpiece or machine.

<8> After moving the tool, select a measurement direction from the [+X], [-X], [+Y], [-Y], [+Z], and [-Z] soft keys.

<9> Set up "MEASURE CONDITION."
If more than one measurement condition can be specified in "TOUCH SENSOR POSITION MEASUREMENT" for measurement preparation, specify which measurement condition is to be used in measurement.

<10>After entering data in "MEASURE DIRECTION," press the [MESURE] soft key. The tool touches the touch sensor automatically, and the current position of the measurement point is displayed as the measurement result.

<11>After performing measurement, press the [→] cursor key to select [T-TOOL] tab.
If you want to specify a milling tool offset number as the item for which the offset value is to be set, go to select [M-TOOL] tab.

> **NOTE**
> With the CNC for a machining center, the [T-TOOL] tab is not displayed. In this case, proceed to step <16>.

<12>Enter a turning tool offset number in "TOOL OFFSET NO. T-SIDE."
When an offset number is entered, the current offset value for the offset number is displayed on the right section of the screen.

<13>In "OFFSET KIND," specify an offset value for which the measurement result is to be set.

<14>After entering the necessary data, press the [SET] soft key. The measurement result is set as the tool offset.

> **NOTE**
> When the "tool geometry/wear offset" function is available, the tool wear offset is specified as 0 if the offset obtained in measurement is set as the tool geometry offset. If the offset obtained in measurement is to be set as the tool wear offset, the difference between the measurement result and the original tool geometry offset value is set as the tool wear offset value.

<15>To measure an additional tool in succession, return to the [T-SELECT] tab.

<16>Pressing the [→] cursor key displays the [M-TOOL] tab, on which it is possible to specify a milling tool offset number as the item for which the offset value is to be set.

> **NOTE**
> With the CNC for a lathe, the [M-TOOL] tab is not displayed. In this case, the steps below need not be performed.

<17>Enter a milling tool offset number in "TOOL OFFSET NO. M-SIDE."
When an offset number is entered, the current offset value for the offset number is displayed in the right section of the screen.

<18>In "OFFSET KIND," specify an offset value for which the measurement result is to be set.

<19>After entering the necessary data, press the [SET] soft key. The measurement result is set as the tool offset value.

> **NOTE**
> When the "tool geometry/wear offset" function is available, the tool wear offset is specified as 0 if the offset obtained in measurement is set as the tool geometry offset. If the offset obtained in measurement is to be set as the tool wear offset, the difference between the measurement result and the original tool geometry offset value is set as the tool wear offset value.

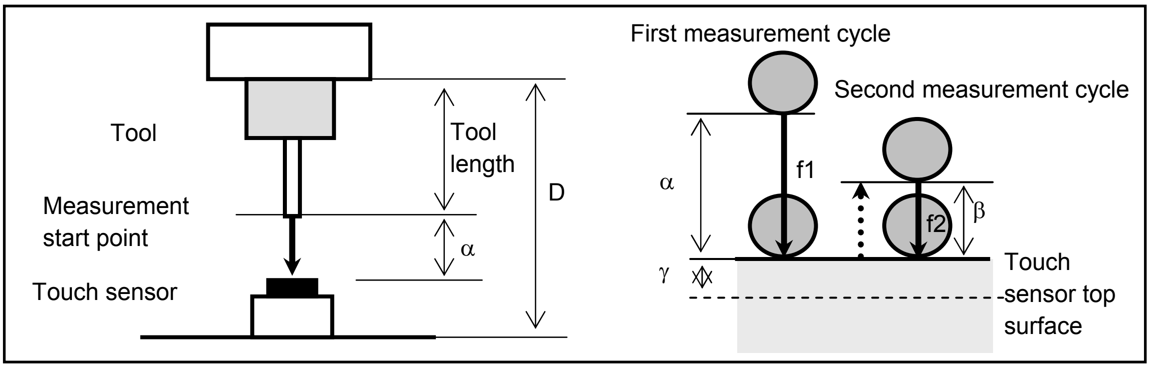
<20>To select another tool, select the [T-SELECT] tab by pressing the [←] cursor key.

Tool selection

A tool select macro program specified in parameter No. 12387 is used for tool selection.

Measurement

Measurements are made as follows:



Meaning	Symbol in the explanation
Feedrate for 1st measurement	f1
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Feedrate for 2nd measurement	f2
Escaping distance for 2nd measurement	ε

<1> Get the tool close to the touch sensor by moving it manually.
<2> Within the range (α + γ) from the measurement start point, the tool moves at a feedrate of f1 to perform the first measurement cycle.
<3> Then, the tool returns through the distance β at the rapid traverse rate. Within the range (β + γ) from the current position, the tool moves at a specified feedrate of f2 to perform the second measurement cycle.
<4> After the second measurement cycle, the tool returns through the distance ε at the rapid traverse speed.

> **NOTE**
> The values of α, β, γ, ε, f1, f2 are specified in the MEASURE CONDITION OF TOOL MEASUREMENT window. Refer to section 3.1.2 of this manual.

Referencing the tool offset value setting screen

Pressing the [OFFSET] soft key on the [TOOL MESUR] screen displays the [TOOL OFFSET] screen. This screen displays the same data as displayed on the tool offset value entry screen when the [T-OFS] soft key is pressed on the base screen.

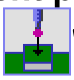
Display coordinate switching

Pressing the [ACTPOS] soft key on the tool measurement screen enables you to switch the display coordinates displayed on the base screen.
Pressing the [PRESET] soft key enables you to set the origin of a relative coordinate system.

1.4 WORK SET

1.4.1 Single Surface Measurement Probe Z-axis

Measurement procedure

<1> Select  "SINGLE SURFACE MEASUREMENT PROBE Z-AXIS" on the [WORK SET] tab of the measurement menu screen. The [SINGLE SURFACE MEASUREMENT PROBE Z-AXIS] screen appears.
<2> By moving the probe manually, get it close to the measurement point where measurement is possible with the movement of the probe along the axis in one direction.
<3> After moving the probe, select a measurement direction from the [+X], [-X], [+Y], [-Y], [+Z], and [-Z] soft keys.
<4> In "MEASURE CONDITION," select a measure condition.
<5> Set up "MEASURE CONDITION." If it is possible to specify more than one measurement condition, specify here which measurement condition is to be used for measurements.
<6> After entering "MEASURE DIRECTION," press, the [MESURE] soft key. The probe touches the measurement point automatically, and the current position of the measurement point is displayed as the measurement result.
<7> Upon completion of measurement, select the [T-WORK] tab by pressing the [→] cursor key.
If you want to set a milling tool workpiece origin offset number as the item for which the offset value is to be set, select "M-WORK" tab.

> **NOTE**
> With the CNC for a machining center, the "T-WORK" tab is not displayed. In this case, proceed to step <13>.

<8> The measurement result appears on the screen. If you want to make measurements only, quit the operation here.
<9> In "WORK COORDINATE NO. T," specify a workpiece coordinate system for which the measurement result is to be set.
(Descriptions of values to be entered)
For G54 → Key in '54'.
For G59→ Key in '59'.
If the coordinate system to be set is anything between G54 and G59, key in the corresponding number between "54" and "59."
If the coordinate system to be set is one of the additional workpiece coordinate sets, enter as follows:
(Descriptions of values to be entered)
For G54.1P1 → Key in '1001'.
For G54.1P48 → Key in '1048'.

> **NOTE**
> The "additional 48 workpiece coordinate system sets" function is an option. This option is unavailable in the turning section of the NC for complex machining.

<10>When a workpiece coordinate system is selected, the current workpiece coordinate system data is displayed on the right section of the screen.
<11>In "WORK COORDINATE VALUE," specify what coordinates in the workpiece coordinate system are to be assigned to the measurement point.
<12>Press the [SET] soft key. A value calculated from the measurement result and the value specified in "WORK COORIDANTE VALUE" is set as the data for the selected workpiece coordinate system.
<13>By selecting the [M-WORK] tab with the [→] cursor key, a milling tool offset number can be specified as the item for which the offset value is to be set.

> **NOTE**
> With the CNC for a lathe, the “WORK M” tab is not displayed. In this case, the steps below need not be performed.

<14>The measurement result appears on the screen. If you want to make measurements only, quit the operation here.
<15>Set values in "WORK COORDINATE NO. M" and "WORK COORDINATE VALUE."
For details of setting, see the operation procedure on the [T-WORK] tab.

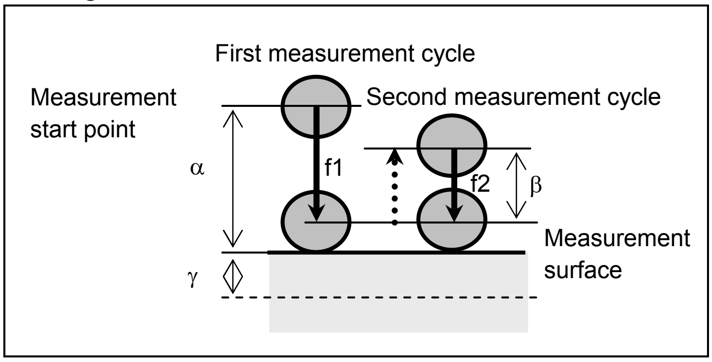
> **NOTE**
> The "additional 48 workpiece coordinate system sets" and "additional 300 workpiece coordinate system sets" functions are options. The "additional 300 workpiece coordinate system sets" option is unavailable on the NC for complex machining.

<16>When a workpiece coordinate system is selected, the current workpiece coordinate system data is displayed on the right section of the screen.
<17>Press the [SET] soft key. A value calculated from the measurement result and the value specified in "WORK COORIDANTE VALUE" is set as the data for the selected workpiece coordinate system.

Measurement

Measurements are made as follows:

● Measuring the end face along the X- or Y-axis



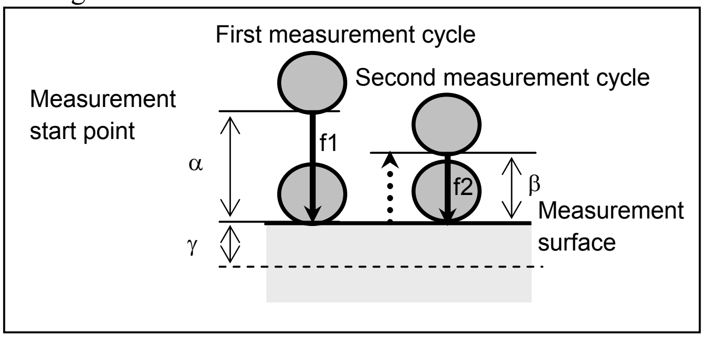
Meaning	Symbol in the explanation
Feedrate for 1st measurement	f1
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ

Meaning	Symbol in the explanation
Feedrate for 2nd measurement	f2
Escaping distance for 2nd measurement	ε

<1> Get the probe close to the measurement position by moving it manually.
<2> When measurement is started, the probe moves at a feedrate of f1 in the range (α + γ - stylus ball radius) from the current position to perform the first measurement cycle.
<3> Then, the probe returns through the distance β at the rapid traverse rate. Within the range (β + γ) from the current position, the probe moves at a feedrate of f2 to perform the second measurement cycle.
<4> After the second measurement cycle, the probe returns through the distance ε at the rapid traverse rate.

> **NOTE**
> The values of α, β, γ, ε, f1, f2 are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

● Measuring the end face along the Z-axis



<1> Get the probe close to the measurement position by moving it manually.
<2> When measurement is started, the probe moves at a feedrate of f1 in the range (α + γ) from the current position to perform the first measurement cycle.
<3> Then, the probe returns through the distance β at the rapid traverse rate. Within the range (β + γ) from the current position, the probe moves at a feedrate of f2 to perform the second measurement cycle.
<4> After the second measurement cycle, the probe returns through the distance ε at the rapid traverse rate.

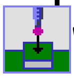
> **NOTE**
> The values of α, β, γ, ε, f1, f2 are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

Referencing the workpiece origin offset value

Press the [WRK CO] soft key. The workpiece origin offset value display window appears. This window lists the workpiece origin offset values.

1.4.2 Single Surface Measurement Probe X-axis

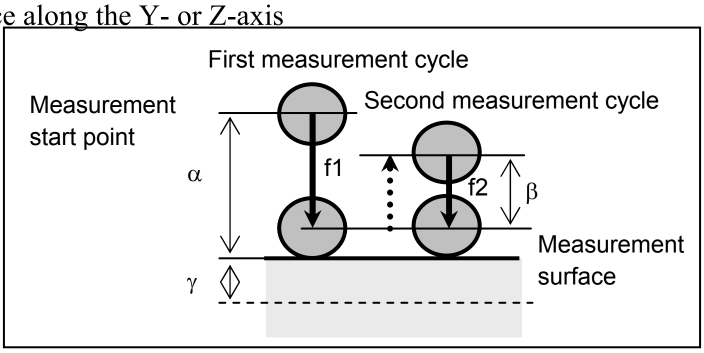
Measurement procedure

<1> Select  "SINGLE SURFACE MEASUREMENT PROBE X-AXIS" on the [WORK SET] tab of the measurement menu screen. The [SINGLE SURFACE MEASUREMENT PROBE X-AXIS] screen appears.
(*) The contents of this screen and what data is input on it are the same as for "SINGLE SURFACE MEASUREMENT PROBE Z-AXIS."

Measurement

Measurements are made as follows:

● Measuring the end face along the Y- or Z-axis

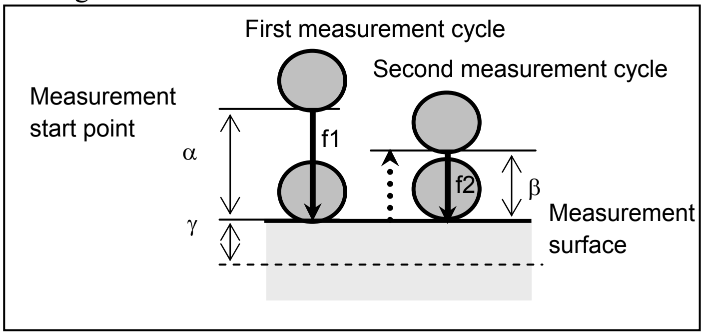


Meaning	Symbol in the explanation
Feedrate for 1st measurement	f1
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Feedrate for 2nd measurement	f2
Escaping distance for 2nd measurement	ε

<1> Get the probe close to the measurement position by moving it manually.
<2> When measurement is started, the probe moves at a feedrate of f1 in the range (α + γ - stylus ball radius) from the current position to perform the first measurement cycle.
<3> Then, the probe returns through the distance β at the rapid traverse rate. Within the range (β + γ) from the current position, the probe moves at a feedrate of f2 to perform the second measurement cycle.
<4> After the second measurement cycle, the probe returns through the distance ε at the rapid traverse rate.

NOTE
The values of α, β, γ, ε, f1, f2 are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

● Measuring the end face along the X-axis



<1> Get the probe close to the measurement position by moving it manually.

<2> When measurement is started, the probe moves at a feedrate of f1 in the range (α + γ) from the current position to perform the first measurement cycle.

<3> Then, the probe returns through the distance β at the rapid traverse rate. Within the range (β + γ) from the current position, the probe moves at a feedrate of f2 to perform the second measurement cycle.

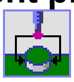
<4> After the second measurement cycle, the probe returns through the distance ε at the rapid traverse rate.

NOTE

The values of α, β, γ, ε, f1, f2 are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

1.4.3 Outside Diameter Measurement

Measurement procedure

<1> Select  "OUTSIDE DIAMETER MEASUREMENT" on the [WORK SET] tab of the measurement menu screen. The [OUTSIDE DIAMETER MEASUREMENT] screen appears.

<2> By moving the probe manually, get it close to the measurement point so that measurement is possible with the movement of the probe along the axis in one direction.

<3> In "MEASURE PLANE" select the measurement plane from the [X-Y] and [Y-Z] soft keys.
The subsequent input item name, input value, and measurement result axis address vary depending on what plane was selected.

<4> Set up "MEASURE CONDITION."

<5> Place the cursor on "1ST PT. MEASURE DIRECT." The [+X], [-X], [+Y], [-Y], [+Z], and [-Z] soft keys appear.

<6> Select a measurement direction from the [+X], [-X], [+Y], [-Y], [+Z], and [-Z] soft keys.
Usually, no change is needed.
To change the measurement direction from the one currently displayed, select a desired direction from the soft keys.

<7> After entering data in "MEASURE DIRECTION," press the [MESURE] soft key. The probe touches the measurement point automatically, and the current position of the measurement point is displayed as the measurement result.

<8> Pressing the [↓] cursor key displays a guide chart for "2ND PT. MEASURE DIRECT."

<9> By moving the probe manually, get it close to the second measurement point so that measurement is possible with the movement of the probe along the axis in one direction, and then make the same measurement as for the first measurement point.

<10>Similarly, make measurements for the third and fourth measurement points.

<11>In "ORIENTED SPINDLE STOP," select [ENABLE] or [DISABLE], using the corresponding soft key.

> **NOTE**
> The "spindle orientation function" is an option.

<12>After measurements are made, placing the cursor on a measurement point displayed on the "MEASURE" screen re-displays the measurement result on that point. Under this condition, pressing the [MESURE] soft key triggers re-measurements on the point.

<13>After measuring the fourth point, select the [T-WORK] tab by pressing the [→] cursor key.

> **NOTE**
> With the CNC for a machining center, the "T-WORK" tab is not displayed. In this case, select the ”M-WORK” tab.

<14>Based on the measurement results on the four points, the center position is displayed on the screen. If you want to perform measurements only, quit the operation here.
The data to be displayed varies depending on what is entered in "MEASURE DIRECTION" on the "MEASURE" screen.

<15>In "WORK COORDINATE NO. T" ("WORK COORDINATE NO. M" in the case of a machining center), specify the workpiece coordinate system for which the measurement result is to be set.

<16>When a workpiece coordinate system is selected, the current workpiece coordinate system data is displayed on the right section of the screen.

<17>In "WORK COORDINATE VALUE," specify what coordinates in the workpiece coordinate system are to be assigned to the measurement point.

<18>Press the [SET] soft key. A value calculated from the measurement result and the value specified in "WORK COORIDANTE VALUE" is set as the data for the selected workpiece coordinate system.

Measurement

Measurements are made as follows:

If [ENABLE] is selected for "ORIENTED SPINDLE STOP," the following operations occur.

<1> If the measurement plane is the X-Y plane, and measurements are to be made in the "+X" direction, before starting measurements, orient the spindle at 0°. If the measurement plane is the Y-Z plane, the target is the "+Y" direction.

<2> If the measurement plane is the X-Y plane, and measurements are to be made in the "-X" direction, before starting measurements, orient the spindle at 180°. If the measurement plane is the Y-Z plane, the target is the "-Y" direction.

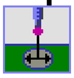
<3> If the measurement plane is the X-Y plane, and measurements are to be made in the "+Y" direction, before starting measurements, orient the spindle at 270°. If the measurement plane is the Y-Z plane, the target is the "+Z" direction.

<4> If the measurement plane is the X-Y plane, and measurements are to be made in the "-Y" direction, before starting measurements, orient the spindle at 90°. If the measurement plane is the Y-Z plane, the target is the "-Z" direction.

> **NOTE**
> The same measurement procedure as for SINGLE SURFACE MEASUREMENT PROBE Z-AXIS applies to the above measurements. See "SINGLE SURFACE MEASUREMENT PROBE Z-AXIS" for details.

1.4.4 Inside Diameter Measurement

Measurement procedure

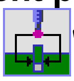
<1> Select  "INSIDE DIAMETER MEASUREMENT" on the [WORK SET] tab of the measurement menu screen. The [INSIDE DIAMETER MEASUREMENT] screen appears.
(*) The items displayed on this screen and the operating procedure for them are the same as for OUTSIDE DIAMETER MEASUREMENT.

Measurement

The same measurement procedure as for OUTSIDE DIAMETER MEASUREMENT applies to INSIDE DIAMETER MEASUREMENT.
(*) See "OUTSIDE DIAMETER MEASUREMENT" for details.

1.4.5 Outside Width Measurement

Measurement procedure

<1> Select "OUTSIDE WIDTH MEASUREMENT" on the [WORK SET] tab of the measurement menu screen. The [OUTSIDE WIDTH MEASUREMENT] screen appears.
<2> By moving the probe manually, get it close to the first measurement point so that measurement is possible with the movement of the probe along the axis in one direction.
<3> In "MEASURE DIRECTION," select the measurement plane and direction from [X-Y X], [X-Y Y], [Y-Z Y], and [Y-Z Z] soft keys.
The subsequent input item name, input value, and measurement result axis address vary depending on what plane was selected.
<4> Set up "MEASURE CONDITION."
<5> Placing the cursor on "1ST PT.
<6> Select a measurement direction from the [+X], [-X], [+Y], [-Y], [+Z], and [-Z] soft keys.
Usually, no change is needed.
<7> After entering data in "1ST PT. MEASURE DIRECT," press the [MESURE] soft key. The probe touches the measurement point automatically, and the current position of the measurement point is displayed as the measurement result.
<8> Pressing the [↓] cursor key displays a guide chart for "2ND PT. MEASURE DIRECT."
<9> By moving the probe manually, get it close to the second measurement point so that measurement is possible with the movement of the probe along the axis in one direction, and then make the same measurement as for the first measurement point.
<10>After measurements are made, placing the cursor on a measurement point displayed on the "MEASURE" screen re-displays the measurement result on that point. Under this condition, pressing the [MESURE] soft key triggers re-measurements on the point.
<11>Upon completion of measurement, select the [T-WORK] tab by pressing the [→] cursor key.

> **NOTE**
> With the CNC for a machining center, the "T-WORK" tab is not displayed. In this case, select the “M-WORK” tab.

<12>Based on the measurement results on the two points, the center position and width are displayed on the screen. If you want to perform measurements only, quit the operation here.
<13>The data to be displayed varies depending on what is entered in "MEASURE DIRECTION" on the "MEASURE" screen.
<14>In "WORK COORDINATE NO. T" (“WORK COORDINATE NO. M” in the case of a machining center), specify the workpiece coordinate system for which the measurement result is to be set.
<15>When a workpiece coordinate system is selected, the current workpiece coordinate system data is displayed on the right section of the screen.

<16>In "WORK COORDINATE VALUE," specify what coordinates in the workpiece coordinate system are to be assigned to the measurement point.

<17>When the [SET] soft key is pressed, a value calculated from the measurement result and the value specified in "WORK COORIDANTE VALUE" is set as the data for the selected workpiece coordinate system.

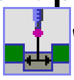
Measurement

The same measurement procedure as for SINGLE SURFACE MEASUREMENT PROBE Z-AXIS applies to the above measurements.

(*) See "SINGLE SURFACE MEASUREMENT PROBE Z-AXIS" for details.

1.4.6 Inside Width Measurement

Measurement procedure

<1> Select "INSIDE WIDTH MEASUREMENT" on the [WORK SET] tab of the measurement menu screen. The [INSIDE WIDTH MEASUREMENT] screen appears.

NOTE

The items displayed on this screen and the operation procedure for them are the same as for OUTSIDE WIDTH MEASUREMENT.
See "OUTSIDE WIDTH MEASUREMENT" for details.

Measurement

The same measurement procedure as for OUTSIDE WIDTH MEASUREMENT applies to the above measurements.

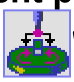
(*) See "OUTSIDE WIDTH MEASUREMENT" for details.

1.4.7 C axis Phase Measurement of Outside Groove

NOTE

When absolute coordinates is not rounded in 0 to 360°(prameter No.1006#1=1,#0=1),and measurement range angle is greater than 180°, Outside width measurement and Inside width measurement is not available.

Measurement procedure

<1> Select "C AXIS PHASE MEASUREMENT OF OUTSIDE GROOVE" on the [WORK SET] tab of the measurement menu screen. The [C AXIS PHASE MEASUREMENT OF OUTSIDE GROOVE] screen appears.

<2> By moving the probe manually, get it close to the first measurement point so that measurement is possible with the movement of the probe along the axis in one direction.

<3> In "MEASURE CONDITION," specify a measurement condition.

<4> In "1ST PT. MEASURE DIRECT," select a measurement direction from the [+C] and [-C] soft keys. Usually, no change is needed.

<5> When the [MESURE] soft key is pressed with the cursor placed on "1ST PT. MEASURE DIRECT," the probe touches the measurement point automatically, and the current position of the measurement point is displayed as the measurement result.

<6> Pressing the [↓] cursor key displays a guide chart for "2ND PT. MEASURE DIRECT."

<7> Retract the probe in the Z-axis direction while keeping it stationary with respect to the X- and Y-axes, and then rotate it around the C-axis.

<8> By moving the probe manually, get it close to the second measurement point so that measurement is possible with the movement of the probe along the Z-axis in one direction, and then make the same measurement as for the first measurement point.

<9> After measurements, placing the cursor on a measurement point displayed on the "MEASURE" screen re-displays the measurement result on that point. Under this condition, pressing the [MESURE] soft key triggers re-measurements on the point.

<10>Upon completion of measurement, select the [T-WORK] tab by pressing the [→] cursor key.

> **NOTE**
> With the CNC for a machining center, the [T-WORK] tab is not displayed. In this case, select the ”M-WORK” tab.

<11>Based on the measurement results on the two points, the center angle is displayed on the screen. If you want to perform measurements only, quit the operation here.

<12>In "WORK COORDINATE NO. T" (“WORK COORDINATE NO. M” in the case of a machining center), specify the workpiece coordinate system for which the measurement result is to be set.

<13>When a workpiece coordinate system is selected, the current workpiece coordinate system data is displayed on the right section of the screen.

<14>In "WORK COORDINATE VALUE," specify what coordinates in the workpiece coordinate system are to be assigned to the measurement point.

<15>When the [SET] soft key is pressed, a value calculated from the measurement result and the value specified in "WORK COORIDANTE VALUE" is set as the data for the selected workpiece coordinate system.

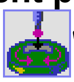
Measurement

The same measurement procedure as for SINGLE SURFACE MEASUREMENT PROBE Z-AXIS applies to the above measurements.

(*) See "SINGLE SURFACE MEASUREMENT PROBE Z-AXIS" for details.

1.4.8 C axis Phase Measurement of Inside Cave

Measurement procedure

<1> Select  "C AXIS PHASE MEASUREMENT OF INSIDE CAVE" on the [WORK SET] tab of the measurement menu screen.

> **NOTE**
> The items displayed on this screen and the operating procedure for them are the same as for C AXIS PHASE MEASUREMENT OF OUTSIDE GROOVE.
> See "C AXIS PHASE MEASUREMENT OF OUTSIDE GROOVE" for detail.

Measurement

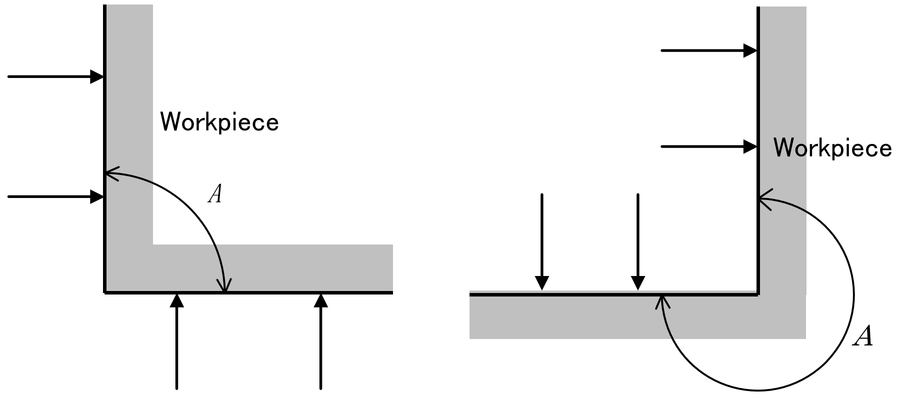
The same measurement procedure as for C AXIS PHASE MEASUREMENT OF OUTSIDE GROOVE applies to the above measurements.

(*) See "C AXIS PHASE MEASUREMENT OF OUTSIDE GROOVE" for detail.

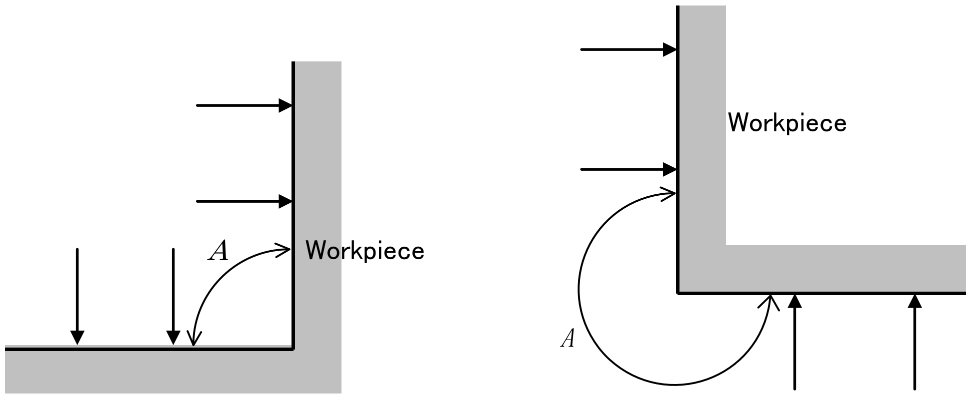
1.4.9 Measurement of Corner Outside/Inside

Four points on the inside of a corner/the outside of a corner are measured to find the angle of the corner and the intersection of the two sides making up the corner.

- Angle of the outside of a corner



- Angle of the inside of a corner

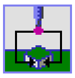


> **NOTE**
> 1 This function is enabled when bit 3 (CNR) of parameter No. 27222 is set to 1.
> 2 This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

Measurement procedure

MEASURE	
Input item	**Meaning**
MEASURE PLANE	Plane to be measured. Select a plane from the [X-Y] and [Y-Z] soft keys.
MEASURE CONDITION	Measurement condition (centering measurement condition group number)
1ST PT. MEASURE DIRECT	Measurement direction for the first point. If X-Y is selected in “MEASURE DIRECTION," only the [+X], [-X], [+Y], and [-Y] soft keys are displayed. Select a desired direction from these soft keys. If Y-Z is selected in “MEASURE DIRECTION," only the [+Y], [-Y], [+Z], and [-Z] soft keys are displayed. Select a desired direction from these soft keys.
2ND PT. MEASURE DIRECT	Measurement direction for the second point. The same values as for measurement of the first point are displayed.
3RD PT. MEASURE DIRECT	Measurement direction for the third point.

MEASURE	
Input item	**Meaning**
4TH PT. MEASURE DIRECT	Measurement direction for the fourth point. The same values as for measurement of the third point are displayed.

<1> Select  "MEASUREMENT OF CORNER OUTSIDE" on the [WORK SET] tab of the measurement menu screen. the [MEASURE] tab screen appears. In "MEASURE PLANE," select a measurement plane from the soft keys. In "MEASURE CONDITION," enter a measurement condition by specifying a numeric value.

<2> On this input screen, set the measurement directions for the first point and third point with the soft keys.
As the measurement direction for the second point, the same value as for the first point is displayed.
As the measurement direction for the fourth point, the same value as for the third point is displayed.
If the measurement direction for the second point is entered before the measurement direction for the first point is entered, the measurement direction for the second point is set for the first point.
If the measurement direction for the fourth point is entered before the measurement direction for the third point is entered, the measurement direction for the fourth point is set for the third point.

<3> Pressing the [MESURE] soft key executes a measurement for the first point. Upon completion of measurement, the result of measurement is displayed in the guide chart.

<4> Similarly, make measurements for the second point, third point, and fourth point.

<5> Display the [T-WORK] tab screen or [M-WORK] tab screen by pressing the [→] cursor key. Either screen is used to specify a workpiece origin offset value number and macro variable for storing the result of measurement.

T-WORK	
Input item	**Meaning**
WORK COORDINATE NO. T	Workpiece origin offset value number for storing the result of measurement
WORK COORD.VALUE X	X coordinate of a measurement position in the specified workpiece coordinate system
WORK COORD.VALUE Y	Y coordinate of a measurement position in the specified coordinate system
MACRO VARIABLE *	Macro variable number for storing the result of measurement. By default, the value set in parameter No. 27246 is displayed. If 0 is set in the parameter, the setting of no value is assumed. If a variable number is set, a measured corner angle is stored in the macro variable.

If workpiece coordinates X and Y, and a macro variable are not set, no data is stored in the list of measurement results.

NOTE
With the CNC for a machining center, the [T-WORK] tab is not displayed.

M-WORK	
Input item	**Meaning**
WORK COORDINATE NO. M	Workpiece origin offset value number for storing the result of measurement
WORK COORD.VALUE X	X coordinate of a measurement position in the specified workpiece coordinate system
WORK COORD.VALUE Y	Y coordinate of a measurement position in the specified coordinate system
MACRO VARIABLE *	Macro variable number for storing the result of measurement. By default, the value set in parameter No. 27246 is displayed. If 0 is set in the parameter, the setting of no value is assumed. If a variable number is set, a measured corner angle is stored in the macro variable.

If workpiece coordinates X and Y, and a macro variable are not set, no data is stored in the list of measurement results.

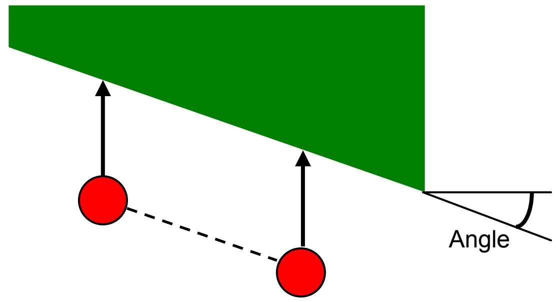
NOTE
With the CNC for a lathe, the [M-WORK] tab is not displayed.

Others

- The three-dimensional slant of a plane cannot be measured.
- No slant measurement based on C-axis operation can be made.
- The first and second measurement points are located on the same end face of a workpiece.
- The third and fourth measurement points are located on the same end face of a workpiece.

1.4.10 Angled Work Measurement

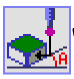
The angle of a slanted workpiece can be measured. A measured angle is output to a specified macro variable, and coordinate system rotation based on the result of output is possible.



(Measurement of the Angle of a Slanted Workpiece)

NOTE
1 This function is enabled when bit 2 (AWM) of parameter No. 27222 is set to 1.
2 This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

Measurement procedure

Select  "ANGLED WORK MEASUREMENT" on the [SET ERROR] tab of the measurement menu screen. Then measure by using the procedure below.

<1> On the [MEASURE] tab screen, select a measurement plane from the soft keys.
<2> Enter a measurement condition by specifying a numeric value.
<3> Set the measurement directions for the first point and second point with the soft keys.
<4> Pressing the [MESURE] soft key executes a measurement for the first point. Upon completion of measurement, the result of measurement is displayed in the guide chart.
<5> Similarly, make a measurement for the second point.
<6> Display the "VALIABLE T" or "VALIABLE M" tab screen by pressing the [→] cursor key. The guide chart displays the workpiece slant (angle) calculated from the measurement results of the two points.
In the input item "MACRO VARIABLE," specify a macro variable number for feeding back the result of measurement. By default, the value set in parameter No. 27246 is displayed. The guide chart displays the value currently set in the specified macro variable.

If the macro variable specified in the input item "MACRO VARIABLE" does not exist or no macro variable number is set in "MACRO VARIABLE," the guide chart displays no currently set macro variable value.

NOTE

1. With the CNC for a machining center, the "VALIABLE T" tab is not displayed. With the CNC for a lathe, the "VALIABLE M" tab is not displayed.
2. As a macro variable to be used with the [VALIABLE T] tab or [VALIABLE M] tab, a custom macro variable is used for #100 to #999.
   For other than #100 to #999, a P-CODE macro variable is used.

<7> When the [SETING] soft key is pressed, the workpiece slant angle obtained from the result of measurement is set in a specified macro variable. When the [SETING] soft key is pressed, the angle calculated from the result of measurement and the macro variable number for storing the angle are saved to the list of measurement results.

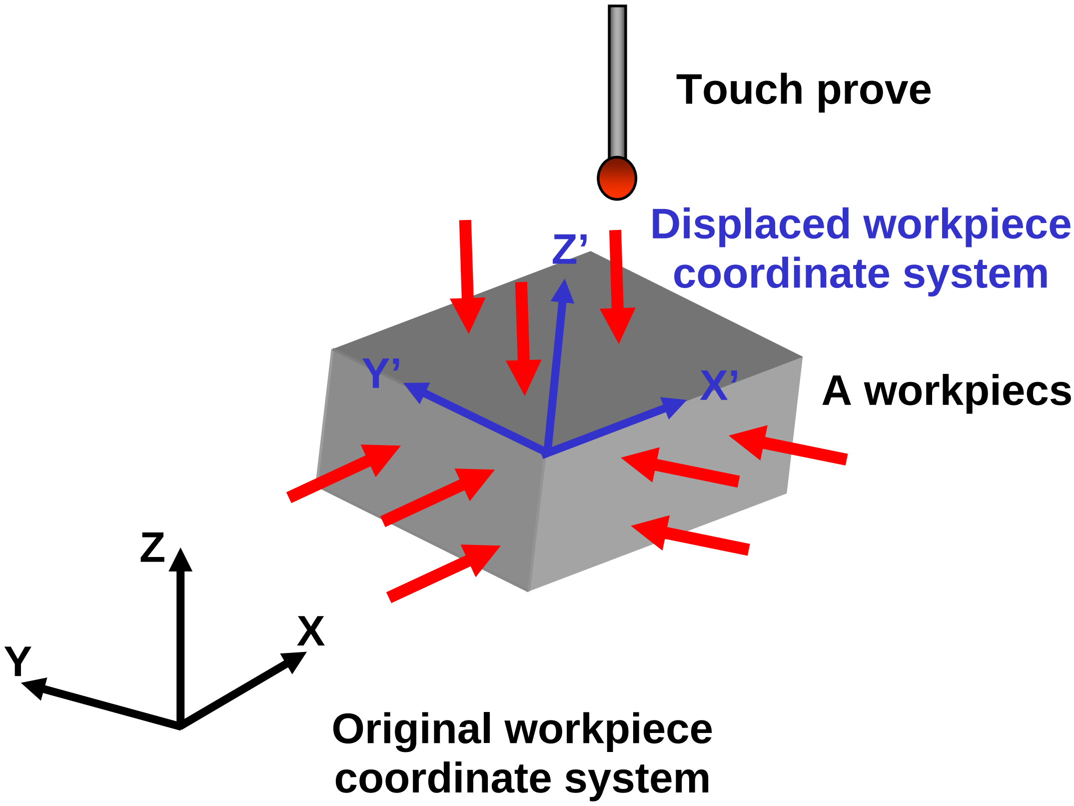
<8> When the [ROTATE] soft key is pressed, the coordinate system rotation command G68 is output with the angle set in the macro variable specified by the input item "MACRO VARIABLE," thus automatically rotating the coordinate system.
Even before a measurement is executed or the [SETING] soft key is pressed, coordinate system rotation can be performed by pressing the [ROTATE] soft key.

NOTE

1. To execute the coordinate system rotation command, the option for coordinate system rotation is required.
2. Pressing the [ROTATE] soft key executes the following command:
   G68 X#[x] Y#[y] R #[r]
   where, "#[r]" represents the macro variable for storing an angle.
   The variable number “#[x]” is the value set in parameter No. 12383 plus 6.
   The variable number “#[y]” is the value set in parameter No. 12383 plus 7.
   Measure the angle of a slanted workpiece, with the rotation center for coordinate system rotation set beforehand in the variables ”#[x]” and ”#[y]."
3. If bit 6 of parameter No. 3402 is set to 1, and bit 0 of parameter No. 3408 is set to 0, the coordinate system rotation command is cleared by a reset signal.

1.4.11 Workpiece Setting Error Measurement

This function measures three planes (or nine points) of a tilted work, and calculates the workpiece setting error. It is possible to output the calculated workpiece setting error to CNC and to use the workpiece setting error in the workpiece setting error compensation function.



NOTE

1 The option "Workpiece setting error compensation" is necessary to use this function.

2 The following parameter setting is necessary to use this function.

27222#6=1	Workpiece setting error measurement function is available.
27222#7=0	Display Y axis measurement cycle and input data for Y axis direction function.
27253	Set start number of macro variable area (71 and over) for calculating workpiece setting error.

NOTE

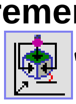
1 Only rectangular parallelepiped workpiece can be measured.

2 The measurement range θ of the rotation error is –90° < θ < 90°.

3 Only Z axis direction can be used as the prove axis.

4 The three points are measured on the each X-Y plane, Y-Z plane, and Z-X plane. As for the limitation of the three points measurement, if the three points are very closed or the three points are placed on the nearly straight line, the right result might be lost. So measure like drawing big an isosceles triangle.

Measurement procedure

Select  "Workpiece setting error measurement" on the [SET ERROR] tab of the measurement menu screen, and measure the three planes (or nine points) as following order.

XY-PLANE	
Input item	**Meaning**
MEASUREMENT COND.	The measurement condition (group no of measurement condition of WORK SET and MEASURE).The same value as YZ-plane and ZX-plane is displayed.
1ST MEASUREMENT DRT.(XY-plane TAB)	The measurement direction when the first point is measured.[-Z] softkey is displayed.
2ND MEASUREMENT DRT.(XY-plane TAB)	The measurement direction when the second point is measured.The same value as the first point is displayed.
3RD MEASUREMENT DRT.(XY-plane TAB)	The measurement direction when the third point is measured.The same value as the first point is displayed.

YZ-PLANE	
Input item	**Meaning**
MEASUREMENT COND.	The measurement condition (group no of measurement condition of WORK SET and MEASURE).The same value as XY-plane and ZX-plane is displayed.
1ST MEASUREMENT DRT.(YZ-plane TAB)	The measurement direction when the first point is measured. [+Z] [-Z] softkey is displayed.
2ND MEASUREMENT DRT.(YZ -plane TAB)	The measurement direction when the second point is measured.The same value as the first point is displayed.
3RD MEASUREMENT DRT.(YZ -plane TAB)	The measurement direction when the third point is measured.The same value as the first point is displayed.

ZX-PLANE	
Input item	**Meaning**
MEASUREMENT COND.	The measurement condition (group no of measurement condition of WORK SET and MEASURE).The same value as XY-plane and YZ-plane is displayed.
1ST MEASUREMENT DRT.(ZX-plane TAB)	The measurement direction when the first point is measured.[+Y] [-Y] softkey is displayed.
2ND MEASUREMENT DRT.(ZX-plane TAB)	The measurement direction when the second point is measured.The same value as the first point is displayed.
3RD MEASUREMENT DRT.(ZX-plane TAB)	The measurement direction when the third point is measured.The same value as the first point is displayed.

<1> Enter the measurement condition as numeric value in the screen of the [XY-plane] TAB.
<2> Specify the measurement direction for the first point with softkey.
<3> Push [MEASURE] softkey, and the measurement for the first point is performed, and after the measurement, the measurement result is displayed in the guide chart.
<4> Similarly, perform the measurement for the second and third point.
<5> Similarly, perform the measurement in the [YZ-plane] TAB and [ZX-plane] TAB, too. After the measurement is performed for the ninth point, the rotation error and corner coordinate are calculated.

WORK SET	
Input item	**Meaning**
WORK SETTING ERR.NO	A workpiece setting error NO.01 through NO.07 for storing the measurement result.
CORNER COORD.VAL.X	Target work corner position X in the currently selected work coordinate system.
CORNER COORD.VAL.Y	Target work corner position Y in the currently selected work coordinate system.
CORNER COORD.VAL.Z	Target work corner position Z in the currently selected work coordinate system.

<6> Enter the workpiece setting error number as numeric value in the screen of the [SET-WORK] TAB. The workpiece setting error of specified number is displayed in the guide chart.

<7> Enter the corner coordinate value (X axis) as numeric value. The target is a corner where the three measured plane intersect.

<8> Similarly, enter the corner coordinate value (Y axis) and the corner coordinate value (Z axis) as numeric value. If the measurement is finished, the error values of corner coordinate is displayed in the guide chart.

<9> Push [SET] softkey, the workpiece setting error value is written. The workpiece setting error is updated in the guide chart. The MEASUREMENT RESULT LIST is updated.

NOTE

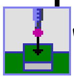
1 When [SET] softkey is pushed while all measurement for three plane is not finished, the warning “EXEC MEASUREMENT.” is displayed.

2 When [SET] softkey is pushed while “WORK SETTING ERR.NO” and “CORNER COORD.VALUE” is not entered, the warning “SHORT INPUT DATA.” is displayed.

1.5 MEASURE

1.5.1 Single Surface Measurement Probe Z-axis

Measurement procedure

<1> Select  "SINGLE SURFACE MEASUREMENT PROBE Z-AXIS" on the [MEASURE] tab of the measurement menu screen. The [SINGLE SURFACE MEASUREMENT PROBE Z-AXIS] screen appears.
(*) The contents of the "MEASURE" tab are the same as for "SINGLE SURFACE MEASUREMENT PROBE Z-AXIS" on the "WORK SET" tab.

<2> By selecting the [T-TOOL] tab with the [→] cursor key, a turning tool offset number can be specified in the offset value setting item.

NOTE
With the CNC for a machining center, the [T-TOOL] tab is not displayed. In this case, proceed to step <7>.

<3> In "TOOL OFFSET NO. T-SIDE," specify a turning tool offset number.
When an offset number is entered, the current offset value for the offset number is displayed on the right section of the screen.

<4> Select a value for "OFFSET KIND," using the soft keys.

<5> In "TARGET VALUE," specify the coordinate of the desired post-machining end face. After the coordinate is entered, a value obtained by multiplying a difference between the target value and the measurement result by the COEFFICIENT FOR SETTING TOOL OFFSET is displayed as the setting value.
(How to calculate the setting value)
The setting value is calculated as follows:

Measurement direction	Setting value
±X, ±Y, ±Z	(Target value – measurement result (absolute coordinate)) × COEFFICIENT FOR SETTING TOOL OFFSET

NOTE
The COEFFICIENT FOR SETTING TOOL OFFSET is specified as a measurement condition.

<6> After entering the necessary data, press the [SET] soft key. The measurement result is set as the tool offset value.

NOTE
A value displayed as the setting value is added to the offset value for the item specified in OFFSET KIND.

<7> By selecting the [M-TOOL] tab with the [→] cursor key, a milling tool offset number can be specified in the offset value setting item.

NOTE
With the CNC for a lathe, the [M-TOOL] tab is not displayed. In this case, the steps below need not be performed.

<8> In "TOOL OFFSET NO. M-SIDE," specify a milling tool offset number.
When an offset number is entered, the current offset value for the offset number is displayed on the right section of the screen.

<9> Select a value for "OFFSET KIND," using the soft keys.

<10>In "TARGET VALUE," specify the coordinate of the desired post-machining end face. After the coordinate is entered, a value obtained by multiplying a difference between the target value and the measurement result by the COEFFICIENT FOR SETTING TOOL OFFSET is displayed as the setting value.

(How to calculate the setting value)

The setting value is calculated as follows:

Measurement direction	Setting value
+X, +Y, +Z	-(Target value – measurement result (absolute coordinate)) × COEFFICIENT FOR SETTING TOOL OFFSET
-X, -Y, -Z	(Target value – measurement result (absolute coordinate)) × COEFFICIENT FOR SETTING TOOL OFFSET

NOTE

The COEFFICIENT FOR SETTING TOOL OFFSET is specified as a measurement condition.

<11>After entering the necessary data, press the [SET] soft key. The measurement result is set as the tool offset value.

NOTE

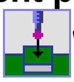
A value displayed as the setting value is added to the offset value specified in the item for which the setting value is to be set.

Measurement

The operating procedure for the above measurements is the same as for "SINGLE SURFACE MEASUREMENT PROBE Z-AXIS" on the "WORK SET".

1.5.2 Single Surface Measurement Probe X-axis

Measurement procedure

<1> Select  "SINGLE SURFACE MEASUREMENT PROBE X-AXIS" on the [MEASURE] tab of the measurement menu screen. The [SINGLE SURFACE MEASUREMENT PROBE X-AXIS] screen appears.

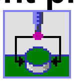
(*) The contents of this screen and the data entered on it are the same as for "SINGLE SURFACE MEASUREMENT PROBE Z-AXIS."

Measurement

The operating procedure for the above measurements are the same as for "SINGLE SURFACE MEASUREMENT PROBE X-AXIS" on the "WORK SET".

1.5.3 Outside Diameter Measurement

Measurement procedure

<1> Select  "OUTSIDE DIAMETER MEASUREMENT" on the [MEASURE] tab of the measurement menu screen. The [OUTSIDE DIAMETER MEASUREMENT] screen appears.

(*) The contents of this "MEASURE" tab are the same as for "OUTSIDE DIAMETER MEASUREMENT" on the "WORK SET".

<2> By selecting the [T-TOOL] tab with the [→] cursor key, a turning tool offset number can be specified in the offset value setting item.

> **NOTE**
> With the CNC for a machining center, the [T-TOOL] tab is not displayed. In this case, proceed to step <7>.

<3> Enter a turning tool offset number in "TOOL OFFSET NO. T-SIDE."
When an offset number is entered, the current offset value for the offset number is displayed on the right section of the screen.
<4> Select a value for "OFFSET KIND," using the soft keys.
<5> In "TARGET VALUE," specify the desired post-machining outside diameter value. After the value is entered, the value obtained by dividing the difference between the target value and the measurement result by 2 then multiplying by the COEFFICIENT FOR SETTING TOOL OFFSET is displayed as the setting value.
(How to calculate the setting value)
The setting value is calculated as follows:

Measurement direction	Setting value
X-Y, Y-Z	(Target value – measurement result) ÷ 2 × COEFFICIENT FOR SETTING TOOL OFFSET

> **NOTE**
> The COEFFICIENT FOR SETTING TOOL OFFSET is specified as a measurement condition.

<6> After entering the necessary data, press the [SET] soft key. The measurement result is set as the tool offset value.

> **NOTE**
> A value displayed as the setting value is added to the offset value for the item specified in OFFSET KIND.

<7> By selecting the [M-TOOL] tab with the [→] cursor key, a milling tool offset number can be specified in the offset value setting item.

> **NOTE**
> With the CNC for a lathe, the “M-TOOL” screen is not displayed.

<8> In "TOOL OFFSET NO. M-SIDE," specify a milling tool offset number.
When an offset number is entered, the current offset value for the offset number is displayed on the right section of the screen.
<9> Select a value for "OFFSET KIND," using the soft keys.
<10>In "TARGET VALUE," specify the desired post-machining outside diameter value. After the value is entered, the value obtained by multiplying a difference between the target value and the measurement result by the COEFFICIENT FOR SETTING TOOL OFFSET is displayed as the setting value.
(How to calculate the setting value)
The setting value is calculated as follows:

Measurement direction	Setting value
X-Y, Y-Z	(Target value – measurement result) ÷ 2 × COEFFICIENT FOR SETTING TOOL OFFSET

> **NOTE**
> The COEFFICIENT FOR SETTING TOOL OFFSET is specified as a measurement condition.

<11>After entering the necessary data, press the [SET] soft key. The measurement result is set as the tool offset value.

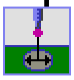
> **NOTE**
> A value displayed as the setting value is added to the offset value for the item specified in OFFSET KIND.

Measurement

The contents are the same as for "OUTSIDE DIAMETER MEASUREMENT" on the "WORK SET".

1.5.4 Inside Diameter Measurement

Measurement procedure

<1> Select  "INSIDE DIAMETER MEASUREMENT" on the [MEASURE] tab of the measurement menu screen. The [INSIDE DIAMETER MEASUREMENT] screen appears.

(*) The items displayed on this screen and the operating procedure for them are the same as for OUTSIDE DIAMETER MEASUREMENT.

(How to calculate the setting value)

The setting value is calculated as follows:

T-TOOL screen

Measurement direction	Setting value
X-Y, Y-Z	(Target value – measurement result) ÷ 2 × COEFFICIENT FOR SETTING TOOL OFFSET

M-TOOL screen

Measurement direction	Setting value
X-Y, Y-Z	-(Target value – measurement result) ÷ 2 × COEFFICIENT FOR SETTING TOOL OFFSET

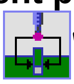
> **NOTE**
> The COEFFICIENT FOR SETTING TOOL OFFSET is specified as a measurement condition.

Measurement

The measurement procedure for this screen is the same as for "INSIDE DIAMETER MEASUREMENT" on the "WORK SET".

1.5.5 Outside Width Measurement

Measurement procedure

<1> Select  "OUTSIDE WIDTH MEASUREMENT" on the [MEASURE] tab of the measurement menu screen. The [OUTSIDE WIDTH MEASUREMENT] screen appears.

(*) The contents of the [MEASURE] tab are the same as for "OUTSIDE WIDTH MEASUREMENT" on "WORK SET."

<2> By selecting the [T-TOOL] tab with the [→] cursor key, a turning tool offset number can be specified in the offset value setting item.

NOTE
With the CNC for a machining center, the [T-TOOL] tab is not displayed. In this case, proceed to step <7>.

<3> Enter a turning tool offset number in "TOOL OFFSET NO. T-SIDE."
<4> When an offset number is entered, the current offset value for the offset number is displayed on the right section of the screen.
<5> Select a value for "OFFSET KIND," using the soft keys.
<6> In "TARGET VALUE," specify the desired post-machining groove width value. After the value is entered, the value obtained by multiplying a difference between the target value and the measurement result by the COEFFICIENT FOR SETTING TOOL OFFSET is displayed as the setting value.
(How to calculate the setting value)
The setting value is calculated as follows:

Measurement direction	Setting value
X, Y, Z	(Target value – measurement result) ÷ 2 × COEFFICIENT FOR SETTING TOOL OFFSET

NOTE
The COEFFICIENT FOR SETTING TOOL OFFSET is specified as a measurement condition.

<7> After entering the necessary data, press the [SET] soft key. The measurement result is set as the tool offset value.

NOTE
A value displayed as the setting value is added to the offset value for the item specified in OFFSET KIND.

<8> By selecting the [M-TOOL] tab with the [→] cursor key, a milling tool offset number can be specified in the offset value setting item.

NOTE
With the CNC for a lathe, the [M-TOOL] tab is not displayed. In this case, the steps below need not be performed.

<9> Enter a milling tool offset number in "TOOL OFFSET NO. M-SIDE."
<10>When an offset number is entered, the current offset value for the offset number is displayed on the right section of the screen.
Select a value for "OFFSET KIND," using the soft keys.
<11>In "TARGET VALUE," specify the desired post-machining groove width value. After the value is entered, the value obtained by multiplying a difference between the target value and the measurement result by the COEFFICIENT FOR SETTING TOOL OFFSET is displayed as the setting value.
(How to calculate the setting value)
The setting value is calculated as follows:

Measurement direction	Setting value
X, Y, Z	(Target value – measurement result) ÷ 2 × COEFFICIENT FOR SETTING TOOL OFFSET

NOTE
The COEFFICIENT FOR SETTING TOOL OFFSET is specified as a measurement condition.

<12>After entering the necessary data, press the [SET] soft key. The measurement result is set as the tool offset value.

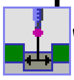
> **NOTE**
> A value displayed as the setting value is added to the offset value for the item specified in OFFSET KIND.

Measurement

The contents are the same as for "OUTSIDE WIDTH MEASUREMENT" on the "WORK SET".

1.5.6 Inside Width Measurement

Measurement procedure

<1> Select  "INSIDE WIDTH MEASUREMENT" on the [MEASURE] tab of the measurement menu screen. The [INSIDE WIDTH MEASUREMENT] screen appears.

(*) The items displayed on this screen and the operating procedure for them are the same as for OUTSIDE WIDTH MEASUREMENT.

(How to calculate the setting value)

The setting value is calculated as follows:

T-TOOL screen

Measurement direction	Setting value
X,Y,Z	(Target value – measurement result) ÷ 2 × COEFFICIENT FOR SETTING TOOL OFFSET

M-TOOL screen

Measurement direction	Setting value
X,Y,Z	-(Target value – measurement result) ÷ 2 × COEFFICIENT FOR SETTING TOOL OFFSET

> **NOTE**
> The COEFFICIENT FOR SETTING TOOL OFFSET is specified as a measurement condition.

Measurement

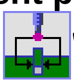
The contents are the same as for "INSIDE WIDTH MEASUREMENT" on the "WORK SET".

1.5.7 Outside/Inside Width Work Setup（with a Slant Angle)

When a groove or a projection is slanted, the width can be measured.

> **NOTE**
> 1 This function is enabled when bit 5 (GANG) of parameter No. 27220 is set to 1.
> 2 This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

Measurement procedure (example of outside width measurement)

<1> Select  "OUTSIDE WIDTH MEASUREMENT" on the [MEASURE] tab of the measurement menu screen. The following input items appear:

MEASURE	
Input item	**Meaning**
MEASURE PLANE	Measurement plane and measurement direction. Select a plane from the [X-Y] and [Y-Z] soft keys.
MEASURE CONDITION	Measurement condition (centering measurement condition group number)
SLANT ANGLE	Set the slant of a groove or projection. (Counterclockwise rotation represents a plus angle, with the +X axis representing 0°.)
1ST PT. MEASURE ANGLE	Measurement direction for the first point. Automatically set from the slant angle. The set value is (slant angle + 90°).
2ND PT. MEASURE ANGLE	Measurement direction for the second point. Automatically set from the slant angle. The set value is (slant angle - 90°).

NOTE

The values of "1ST PT. MEASURE ANGLE" and "2ND PT. MEASURE ANGLE" follow the setting of bit 7 (ANG) of parameter No. 27220.

In this input item, select a measurement plane from the soft keys.
Entering a measurement plane by pressing the soft key when manual measurement execution is completed clears the result of measurement.

<2> Enter a measurement condition by specifying a numeric value.
<3> Enter a slant angle.
<4> Enter a measurement direction for the first point. A measurement direction is normal to the rotation angle.
<5> Press the [MESURE] soft key. The probe automatically starts moving in the specified measurement direction. Upon completion of measurement of the first point, the guide chart displays the result of measurement.
<6> Similarly, make a measurement of the second point.
<7> Display the [T-TOOL] or [M-TOOL] screen by pressing the [→] cursor key. The guide chart displays an outside width calculated from the measurement results of the two points.
<8> Set "TOOL OFFSET NO." and "TARGET VALUE." The guide chart displays the currently specified workpiece origin offset number.
<9> Press the [SETING] soft key. The result of measurement is set with the specified offset number.

The same [T-TOOL] and [M-TOOL] tabs are used for inside width measurement and outside width measurement.

T-TOOL	
Input item	**Meaning**
TOOL OFFSET NO. T-SIDE	Offset number for storing the result of measurement
OFFSET KIND T	Set data such as figure, wear, and length compensation.
TARGET VALUE	Enter the dimensions of a final figure.

NOTE

With the CNC for a machining center, the [T-TOOL] tab is not displayed.

M-TOOL	
Input item	**Meaning**
TOOL OFFSET NO. M-SIDE	Offset number for storing the result of measurement
OFFSET KIND T	Set data such as figure, wear, and length compensation.
TARGET VALUE	Enter the dimensions of a final figure.

> **NOTE**
> With the CNC for a lathe, the [M-TOOL] tab is not displayed.

Others

- The three-dimensional slant of a plane cannot be measured.
- No slant measurement based on C-axis operation can be made.

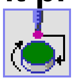
> **NOTE**
> This function is disabled when bit 7 (NOY) of parameter No. 27222 is set to 1.

1.5.8 Outside Diameter Measurement（Work Rotation Type）

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the outside diameter of the circle is obtained from the average of the results.

> **NOTE**
> This function is enabled when bit 0 (RCR) of parameter No. 27222 is set to 1.

Measurement procedure

<1> Select  "OUTSIDE DIAMETER MEASUREMENT-WORK ROTATION" on the [MEASURE] tab of the measurement menu screen. The [ORIGIN] tab screen appears. On this screen, enter "CENTER PT.(1ST AXIS)" and "CENTER PT.(2ND AXIS)" as values in the workpiece coordinate system.

<2> After data input, press the [→] cursor key. The [MEASURE] tab screen appears. On this screen, select a measurement plane from the soft keys.

<3> In “MEASURE DIRECTION,” select a measurement direction from the soft keys.

<4> In “MEASURE CONDITION,” enter a measurement condition by specifying a numeric value.

<5> In “MEASURE ANGLE,” enter a measurement angle by specifying a numeric value.

<6> After moving the probe manually to the measurement start position, enter data then press the [MESURE] soft key. A measurement is started. Upon completion of measurement, the screen displays the result of measurement.

<7> Similarly, enter a measurement angle in "2ND PT. MEASURE ANGLE," "3RD PT. MEASURE ANGLE," and "4TH PT. MEASURE ANGLE" to execute measurement.

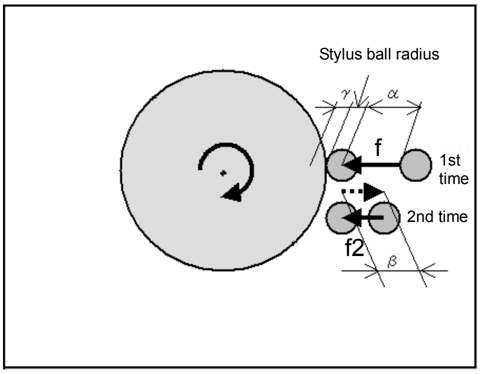
<8> Press the [→] cursor key. The [T-TOOL] screen appears.
On this screen, set the offset value calculated from the result of measurement, as a turning tool offset value.
This screen displays the same information and operation procedure as for "MEASURE OUTSIDE DIAMETER MEASUREMENT." However, the result of measurement does not indicate "CENTER PT.".

<9> In "OFFSET KIND," specify a tool offset value for which the offset value calculated from the result of measurement is to be set.
The screen displays the same information and operation procedure as for "MEASURE OUTSIDE DIAMETER MEASUREMENT."

Measurement

When rotation axis positioning based on C-axis rotation is used (when bit 2 (CMV) of parameter No. 27223 is set to 1)

A measurement operation with the -X direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified in "MEASURE ANGLE."
<2> A measurement is made in the range (α + γ) at a feedrate of f (first measurement cycle).
<3> Next, the probe returns through the distance β at the rapid traverse rate then moves in the range (β + γ) at a feedrate of f2 from that position to make a measurement (second measurement cycle).
<4> The probe returns through the distance ε in the X-axis direction at the rapid traverse rate.

Meaning	Symbol in the explanation
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Feedrate for 2nd measurement	f2
Escaping distance for 2nd measurement	ε

NOTE
The values of α, β, γ, ε, f, f2 are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

-When rotation axis positioning based on the spindle orientation function is used (when bit 2 (CMV) of parameter No. 27223 is set to 0)

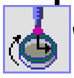
The same measurement operation as for C-axis rotation is performed, except that rotation axis positioning is performed using the spindle orientation function.
If the output of a spindle orientation M code for positioning at a proper angle is disabled because "MEASURE ANGLE" is not set correctly, the alarm "SPECIFY ANGLE CANNOT MOVE" is issued at program execution time.

1.5.9 Inside Diameter Measurement（Work Rotation Type）

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the inside diameter of the circle is obtained from the average of the results.

NOTE
This function is enabled when bit 0 (RCR) of parameter No. 27222 is set to 1.

Measurement procedure

<1> Select  "INSIDE DIAMETER MEASUREMENT-WORK ROTATION" on the [MEASURE] tab of the measurement menu screen. The [ORIGIN] tab screen appears. On this screen, enter "CENTER PT.(1ST AXIS)" and "CENTER PT.(2ND AXIS)" as values in the workpiece coordinate system.

<2> After data input, press the [→] cursor key. The [MEASURE] tab screen appears. On this screen, select a measurement plane from the soft keys.

<3> In “MEASURE DIRECTION,” select a measurement direction from the soft keys.

<4> In “MEASURE CONDITION,” enter a measurement condition by specifying a numeric value.

<5> In “MEASURE ANGLE,” enter a measurement angle by specifying a numeric value.

<6> After moving the probe manually to the measurement start position, enter data then press the [MESURE] soft key. A measurement is started. Upon completion of measurement, the screen displays the result of measurement.

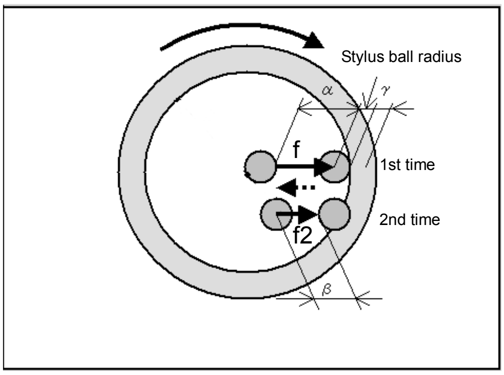
<7> Similarly, enter a measurement angle in "2ND PT. MEASURE ANGLE," "3RD PT. MEASURE ANGLE," and "4TH PT. MEASURE ANGLE" to execute measurement.

<8> The [T-TOOL] tab screen displays the same information as for "OUTSIDE DIAMETER MEASUREMENT."

Measurement

- When rotation axis positioning based on C-axis rotation is used (when bit 2 (CMV) of parameter No. 27223 is set to 1)

A measurement operation with the +X direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified in “MEASURE ANGLE.”

<2> A measurement is made in the range ($\alpha + \gamma$) at a feedrate of f (first measurement cycle).

<3> Next, the probe returns through the distance β at the rapid traverse rate then moves in the range ($\beta + \gamma$) at a feedrate of f2 from that position to make a measurement (second measurement cycle).

<4> The probe returns through the distance ε in the X-axis direction at the rapid traverse rate.

Meaning	Symbol in the explanation
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Feedrate for 2nd measurement	f2
Escaping distance for 2nd measurement	ε

NOTE

The values of α, β, γ, ε, f, f2 are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

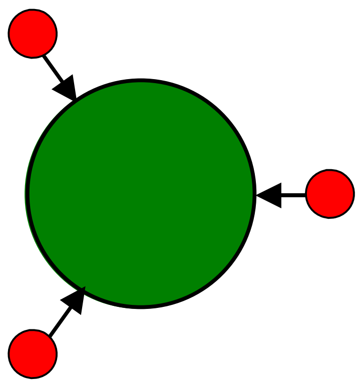
- **When rotation axis positioning based on the spindle orientation function is used (when bit 2 (CMV) of parameter No. 27223 is set to 0)**

The procedure is the same as for outside diameter measurement.

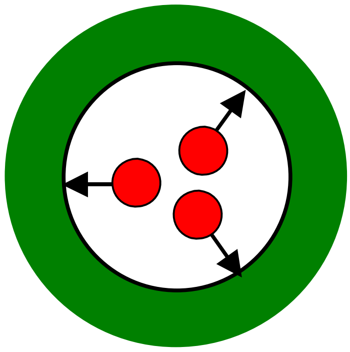
1.6 OTHER FUNCTIONS

1.6.1 Three-Point Measurement of an Arbitrary Angle

In measurement of a stylus ball radius or center offset amount or in measurement of the outside diameter or inside diameter of a circle, an arbitrary angle can be measured. Moreover, a three-point measurement can be made. This means that the center of a half circle can also be measured.



(Measurement of outside diameter of circle)



(Measurement of inside diameter of circle)

NOTE

1 This function is enabled when bit 4 (CANG) of parameter No. 27220 is set to 1.
2 This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

Measurements for which this function is enabled

This function is enabled for the following measurements:

Calibration menu
- "STYLUS BALL DIAMETER CALIBRATION"
- "STYLUS OFFSETS CALIBRATION-A"
- "STYLUS OFFSETS CALIBRATION-B"

Centering function menu
- "OUTSIDE DIAMETER MEASUREMENT"
- "INSIDE DIAMETER MEASUREMENT"

Post-machining inspection menu
- "OUTSIDE DIAMETER MEASUREMENT"
- "INSIDE DIAMETER MEASUREMENT"

Measurement procedure (example of outside diameter measurement)

<1> On the centering function menu select screen for manual measurement, select OUTSIDE DIAMETER MEASUREMENT.

<2> Set each data item on the [ORIGIN] tab screen. The method of setting is the same as for outside diameter measurement with no angle specification.
<3> Switch to the [MEASURE] tab screen then set each data item. When making a three-point measurement, enter data only for three of the four points.

The defaults for measurement angles are displayed as follows:

Input item	Value
1ST PT. MEASURE ANGLE	0°
2ND PT. MEASURE ANGLE	90°
3RD PT. MEASURE ANGLE	180°
4TH PT. MEASURE ANGLE	270°

<4> Move the probe manually to the neighborhood of the center of the circle. Next, place the cursor on "1ST PT. MEASURE ANGLE" then press the [MESURE] soft key.
<5> After retracting by the return distance set as a measurement condition upon completion of the first measurement cycle, execute the second measurement cycle.
<6> Upon completion of measurement, the guide chart displays the result of measurement.
<7> Make measurements for the second, third, and fourth points in succession.
In the case of a three-point measurement, the fourth measurement point need not be measured.
<8> The subsequent measurement procedure is the same as for outside diameter measurement with no angle specification.

NOTE
This function is disabled when bit 7 (NOY) of parameter No. 27222 is set to 1.

1.6.2 Return to the Center Position in Manual Circle Measurement

When bit 1 of parameter No. 27220 is set to 1, a return operation to the position before the start of measurement is performed automatically upon completion of measurement in manual measurement. After the center position of a circle is calculated by measuring three or more points, positioning is performed at the center position of the circle. This function enables high-precision measurement.

NOTE
1 This function is enabled when bit 1 (CNTV) of parameter No. 27220 is set to 1.
2 This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

Measurement procedure

The inside diameter of a circle is measured as follows:
<1> Set each data item on the [ORIGIN] tab screen.
<2> Set each data item on the [MEASURE] tab screen.
<3> Move the probe manually to the neighborhood of the center of the circle. Next, place the cursor on "1ST PT. MEASURE DIRECT" then press the [MESURE] soft key.
<4> Execute the first measurement cycle.
<5> After retracting by the return distance set as a measurement condition upon completion of the first measurement cycle, execute the second measurement cycle.
<6> If the center position of the circle is established after the second measurement cycle, a return operation to "CENTER PT." occurs. If the center position of the circle is not established, a return operation to the position before the start of measurement occurs.
<7> Upon completion of measurement, the guide chart displays the result of measurement.
<8> Make measurements for the second, third, and fourth points in succession.
<9> On the [SET] tab screen, set the result of measurement in each data item.

NOTE

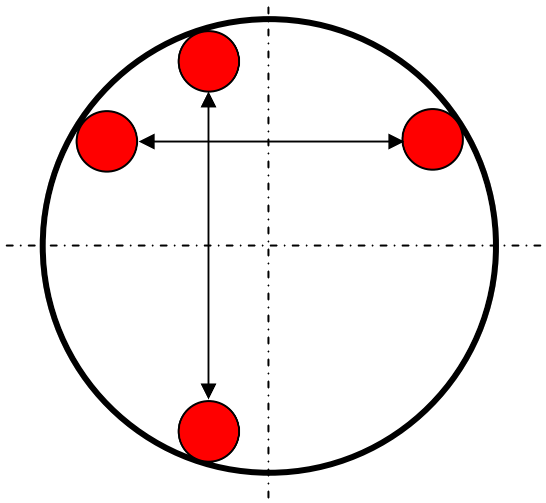
In measurements other than center offset measurement-B, no return operation to the center position is performed until the center coordinates are obtained from the result of measurement of each point. In center offset measurement-B, a return operation to the center coordinates specified on the screen is performed.

1.6.3 Measurement When the Measurement Start Position Is Not on a Center Line of a Circle

In a manual outside diameter or inside diameter measurement, the measurement start position must be on a center line of the circle. If this function is enabled, a correct measurement can be made even when the measurement start position is not on a center line.

NOTE

1 This function is enabled when bit 3 of parameter No. 27220 is set to 0.
2 This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.



Each of the following manual measurements can be made correctly even when the measurement start position is not on a center line of a circle:

“STYLUS BALL DIAMETER CALIBRATION”
“STYLUS OFFSETS CALIBRATION-B”
“OUTSIDE DIAMETER MEASUREMENT” (Post-machining inspection)
“INSIDE DIAMETER MEASUREMENT” (Post-machining inspection)

When this function is enabled, the result of measurement at each measurement point is displayed differently from a case where this function is disabled. The other procedure is the same as when this function is disabled.

Measurement result display

Upon completion of measurement at each measurement point, the result of measurement is displayed at the bottom of the guide chart. When this function is disabled, it is assumed that the measurement start position is on a center line of the circle. So, values obtained by adding "stylus ball radius" to the coordinates where the probe makes a contact are displayed as the result of measurement.
When this function is enabled, however, adding "stylus ball radius" does not produce a correct value if the measurement start position is not on a center line of the circle. So, the coordinates where the probe makes a contact are displayed without modification in this case.

1.6.4 Measurement Plane Selection

If bit 4 (X-Y) of parameter No. 27226 is set to 1 on a manual measurement screen, a measurement is made on the X-Y plane. If bit 5 (Y-Z) of parameter No. 27226 is set to 1, a measurement is made on the Y-Z plane.
If either of these parameters is set to 1, the input item MEASURE PLANE is not displayed.

> **NOTE**
> This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

1.6.5 Measurement Condition Selection

If bit 5 (GRP) of parameter No. 27224 is set to 1, the item MEASURE CONDITION can be hidden. In this case, the number of measurement condition groups is assumed to be 1.

> **NOTE**
> This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

1.6.6 Measurement Direction Selection

If "X-Y" is selected in the input item MEASURE PLANE on a manual measurement screen, the [+Z] and [-Z] soft keys are not displayed for the input item MEASURE DIRECTION. Similarly, if "Y-Z" is selected, the [+X] and [-X] soft keys are not displayed.

> **NOTE**
> This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

1.6.7 Tool Length Compensation in Manual Measurement

When this function is enabled, manual measurement can be executed with tool length compensation activated. To execute manual measurement when this function is disabled, tool compensation needs to be canceled.
When the [SETING] soft key is pressed in probe length measurement, the result of measurement is set as calibration data. At the same time, the result of measurement is set with the tool offset number specified by parameter No. 27247.

> **NOTE**
> 1 This function is enabled when bit 0 (CMPH) of parameter No. 27220 is set to 1.
> 2 This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

Measurement result setting

Press the [SETING] soft key on the PROBE LENGTH CALIBRATION screen for manual measurement.
The result of measurement is feed back to the tool offset number specified by parameter No. 27247.

Command of tool length compensation

When the [SETING] soft key is pressed after the measured of probe length and the measurement result is feed back to the tool offset, it is possible to execute the following tool length compensation command (G43). To execute tool length compensation command, The macro program with the number set by parameter No.27251 is called when the [SETING] soft key is pressed.
The following command of tool length compensation is output from the macro program.

<1> In case that direction of the measurement is –Z.
The following command is output and tool length compensation of z-axis direction is enabled.
- (a) Tool length compensation type A.
G91 G43 Z0 Hbb ; (bb = tool length compensation number specified by parameter No.27247)
- (b) Tool length compensation type B.
G91 G17 G43 Z0 Hbb;
- (c) Tool length compensation type C.
G91 G43 Z0 Hbb;

<2> In case that Direction of the measurement is –X.
The following command is output and tool length compensation of x-axis direction is enabled.
- (a) Tool length compensation type A.
Not execute tool length compensation.
- (b) Tool length compensation type B.
G91 G17 G43 X0 Hbb;
- (c) Tool length compensation type C.
G91 G43 X0 Hbb;

1.6.8 Automatic Output of Tool Rotation Command in Tool Measurement

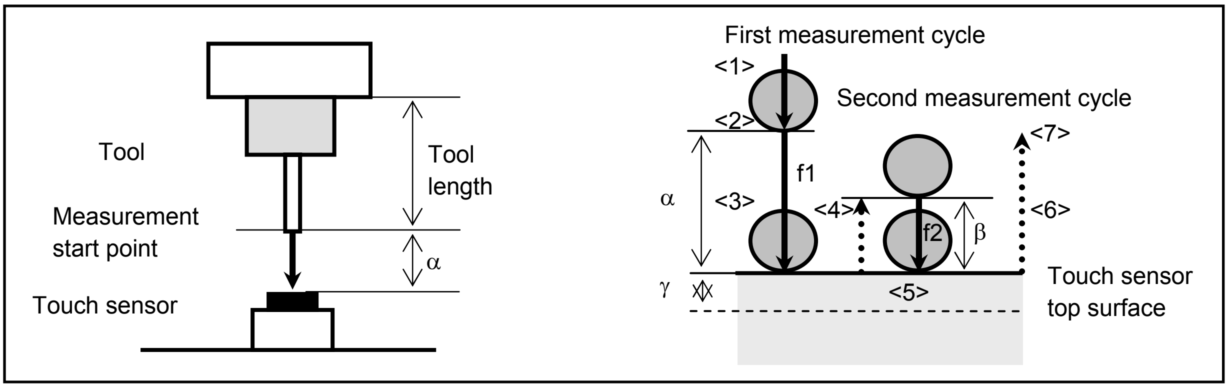
Tool rotation command is automatic output in measurement of rotary tool.
This function is used in case of measuring by rotating a tool in order to measure with accuracy.
This function is available in the tool measurement.

Measurement

The following motions of tool rotate and stop are added for this function.
- At the beginning of measurement, start tool rotation
- At the end of escape after completing measurement, stop tool rotation

The meaning of symbols used in the following explanation is as follows.

Meaning	Symbol in the explanation
Feedrate for the 1st measurement	f1
Approach distance for the 1st measurement	α
Escaping distance for the 1st measurement	β
Overlap distance for measurement	γ
Feedrate for the 2nd measurement	f2
Escaping distance for the 2nd measurement	ε



<1> Get the tool close to the touch sensor by moving it manually.

<2> Push the softkey [MESURE]. Then tool starts rotating according to the data “TOOL ROTATE CMD” and “TOOL ROTATE SPEED” specified in the measurement screen.
In case that [NONE] is specified in “TOOL ROTATE CMD” of the measurement screen, tool does not rotate.

<3> Withn the range ($\alpha + \gamma$) from the measurement start point, the tool moves at a feedrate of f1 to perform the first measurement.

<4> Tool returns through the distance β at the rapid traverse rate.

<5> Withn the range ($\alpha + \gamma$) from the position <4>, the tool moves at the specified feedrate of f2. Then, perform the second measurement.

<6> After the second measurement, the tool returns through the distance ε at the rapid traverse rate.

<7> In case that the tool was rotated at the step <2>, stop rotating of the tool.

Data input screen

In case this function is available, on the [MEASURE] tab screen, “TOOL ROTATION CMD” and “TOOL ROTATION SPEED” are displayed.

Input item	Meaning
TOOL ROTATION CMD	Tool rotation command is non or existence. Tool rotation direction in case of rotating a tool
TOOL ROTATION SPEED	Tool rotation speed

Input item	Indispensability	Data range
TOOL ROTATION CMD(*1)	○	1:Non, 2:Forward, 3:Reverse
TOOL ROTATION SPEED (*1) (*2)	(*3)	0 to 99999999

(*1) In case of setting the parameter 27224#3=0, this input item is not displayed.

(*2) When “Non” is specified for “TOOL ROTATION CMD”, this input item is not displayed.

(*3) When “Forward” or “Reverse” is specified for “TOOL ROTATION CMD”, this input item has to be entered.

Operations

By the following operations, tool measurement with rotating tool can be performed.

<1> Change the manual operation mode

<2> Push the softkey [MEASURE]

<3> Select “1. TOOL MEASRUEMENT” displayed on [TOOL MESUR] tab

<4> Push the softkey [SELECT].

<5> Enter the input item displayed on [TOOL MESUR] tab.

<6> Enter the input item displayed on [MEASURE] tab

- Select “FORWARD” or “REVERSE” for “TOOL ROTATION CMD”
- Enter the data for “TOOL ROTATION SPEED”

<7> Push the softkey [MEAURE]. Then, execute the measurement.

<8> Enter the data for the input item on [T-TOOL] or [M-TOOL] tab.

<9> Push the softkey [SET].

The spindle rotate/stop command format

In Spindle speed control, there is the function such as “SPINDLE OUTPUT CONTROL BY PMC” and “SPINDLE CONTROL WITH SERVO MOTOR”.
The format of spindle rotate/stop command changes by the method of the spindle speed control.
The spindle rotate/stop command format in each spindle speed control is shown below table. In this funtion, spindle rotate/stop command is outputted according to the table shown below.
In case of using other spindle rotation command format except the table shown bellow, it’s possible to use by customizing macro program.

SPINDLE OUTPUT CONTROL BY PMC	SPINDLE CONTROL WITH SERVO MOTOR	MULTI-SPINDLE CONTROL	SPINDLE SELECTION METHOD	SPINDLE ROTATE/STOP COMMAND	SPINDLE ROTATE/STOP COMMAND FORMAT IN MACRO PROGRAM OF FANUC STANDARD (S:SPINDLE SPEED, P:SPINDLE SELECTION)
Not available	SPINDLE	Not available	-	FORWARD	M03 S_ ;
				REVERSE	M04 S_ ;
				STOP	S0 ;
		Avilable	SIGNAL (SWS1 to SWS4)	FORWARD	M03 S_ ; *1
				REVERSE	M04 S_ ; *1
				STOP	S0 ; *1
			ADDRESS “P”	FORWARD	M03 S_ P_ ;
				REVERSE	M04 S_ P_ ;
				STOP	S0 P_ ;
	SERVO AXIS	Not available	-	FORWARD	ALARM
				REVERSE	
				STOP	
		Available	SIGNAL (SWS1 to SWS4)	FORWARD	
				REVERSE	
				STOP	
			ADDRESS “P”	FORWARD	G96.4 P_ ; M03 S_ P_ ;
				REVERSE	G96.4 P_ ; M04 S_ P_ ;
				STOP	S0 P_ ; G96.1 P_ R0 ; *2
Available	CONTROL BY PMC				ALARM

*1 This function does not support the spindle selection by the signal (SWS1 to SWS4). Before measurement, an operator has to select the spindle to be rotating.

*2 In the method to stop the spindle, there is G-code,”G96.1 to G96.3”. In this function, G-code “G96.1” is used.

Customizing the spindle rotate/stop command

On the following case, by customizing a macro program, it’s possible to change the spindle rotation/stop command.

(a) In case the spindle forward /reverse/stop command excepting M03,M04 and S0. is used.
(b) In case of using the spindle selection by “Extended Spindle Name”
(c) In case of using “Spindle Output Control By PMC”
(d) In case of using the spindle stop command by the signal *SSTP1 to *SSTP4
(e) In case of using a selection of SV speed control mode by the signal (SRVON1 to SRVON8).
(f) In case of using a change of spindle rotation direction in SV speed control mode by the signal (SVRVS1 to SVRVS8).

<1> Method of customizing

(a) Macro program for cutomizing, which is called as user macro program in below, is programmed by using P-code macro.
It's necessary to make user macro programs for outputting spindle rotate command and stop command.

(b) Program number of the user macro program for outputting spindle rotate command must be set to the parameter No.27256. Program number of the user macro program for outputting spindle stop command must be the parameter No.27256 setting value +1.

(c) The user macro programs are called by using M-code "M98" for subprogram call. And, input arguments to the user macro programs are as follows.

(1) Spindle rotate command (Macro variable #1)
1 : Non, 2 : Forward, 3 : Reverse

(2) Spindle rotate speed (Macro variable #2)

<2> Execution of the macro program

(a) The user macro program for outputiing spindle rotate command is executed when the measurement is started.

(b) The user macro program for outputting spindle stop command is executed at the end of escape after completing measurement.

1.6.9 Tool Measurement with Multi-step Skip Signals

In this function, imdependent skip signal can be used for tool measurement and workpiece measurement. As the skip signal for tool measurement, Multi-step skip signal is used. And, as the skip signal for workpiece measurement, the skip signal is used as before.

NOTE

1 In order to this function, it's necessary to specify Multi-step skip optional function.

2 On the Multi-step skip function, refer to "16.3.5 Multi-step skip" described in the connection manual (Function) B-63943EN-1.

In order to use this function, it's necessary to set the parameter No.27228#7=1.

Skip signal setting

Setting the parameter No.27258 skip signal number for using the skip signal specified in the measurement condition of tool measurement.
The skip signal number specified in measurement conditions of tool measurement A to D. It's set like "dcba".

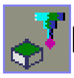
a : The value of Skip signal number "P" specified in tool measurement condition A.
b : The value of Skip signal number "P" specified in tool measurement condition B.
c : The value of Skip signal number "P" specified in tool measurement condition C.
d : The value of Skip signal number "P" specified in tool measurement condition D.

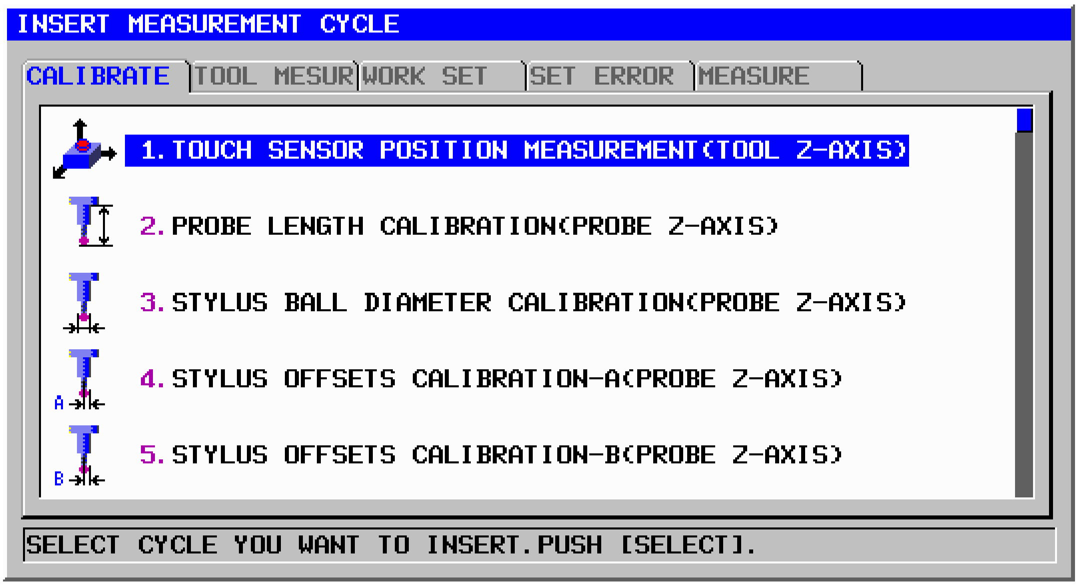
In case of specifying the value with the number of digits exceeding the number of measurement conditions, PS alarms 3775 " ILLEGAL PARAM SETTINGS" occurrs at the execution of measurment.
Specifying "0" is the same to specify "1".
In case of spefifying the value grater than 5, PS alaram 370 "G31P/G04Q ERROR" occuurs at the execution of measurement.

Example) The value "1234" is set to the parameter.
In case of using skip signal specified in the measurement condition A, P4 is outputted.
In case of using skip signal specified in the measurement condition B, P3 is outputted.
In case of using skip signal specified in the measurement condition C, P2 is outputted.
In case of using skip signal specified in the measurement condition D, P1 is outputted.

2 MEASUREMENT CYCLE

2.1 MEASUREMENT CYCLE MENU SCREEN DISPLAY METHOD

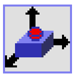
<1> Press the  [MESCYC] soft key on the base screen in the edit mode. The measurement cycle menu screen for selecting measurement type is displayed.
*[MESCYC] soft key might change the following icon according to the machine configuration.



2.2 CALIBRATION (PROBE Z-AXIS DIRECTION) CYCLE

2.2.1 Touch Sensor Position Measurement

When the reference tool is oriented in the Z-axis direction, the position of the touch sensor for tool measurement is measured.

Select  "TOUCH SENSOR POSITION MEASUREMENT (TOOL Z-AXIS)" on the [CALIBRATE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT DIREC.

Select a measurement axis direction from the soft keys.

- MEASUREMENT COND.

Specify a measurement condition group number to be referenced at the time of measurement.
Enter a numeric value.

- REF. TOOL LENGTH

Enter the size of the reference tool in the Z-axis direction by specifying a numeric value.

- REF TOOL RADIUS

Enter the sizes of the reference tool in the X-axis and Y-axis directions by specifying numeric values.

- SPECIFY OF MEAS. PT.

Select a measurement position specification method from the soft keys below.
By default, "SETTIN" is selected.
When "SETTIN" is selected, the position of the touch sensor of the already set measurement condition is referenced.
When "INPUT" is selected, the values entered for "MEASURE POINT" described below are used as the measurement point.

- MEASURE POINT X, Y, Z

Enter the position of the touch sensor in the correct measurement direction by specifying numeric values.
These items are displayed when "INPUT" is selected in "SPECIFY OF MEAS. PT.".

- CLEARANCE

Enter the distance from the position of the touch sensor to the measurement start point by specifying a numeric value.

- MOVING MEAS. SPEED

Enter a feedrate for measurement by specifying a numeric value.

[SETTING] tab

- SWITCH DEST.

Select a calibration data setting item from the soft keys.
As initial value, "OFFSET" is selected.

NOTE

If "REF. VALUE" is selected, the result of measurement is set as the calibration data reference value and the offset value is set to 0 when the result of measurement is set (fed back) as calibration data.
When "OFFSET" is selected, the difference between the calibration data reference value and the result of measurement is set as the offset value.

- SETTING AXIS

Select an axis address for measurement result setting from the soft keys below.
When "ALL-AX" is selected, the result of measurement is set for all of the X-axis, Y-axis and Z-axis at the same time.

- OK RANGE (±)

Specify an allowable range of errors obtained from measurement.
If the difference between the obtained result of measurement and the touch sensor position of the calibration data currently specified with "MEASUREMENT COND." (axis coordinate specified by "SETTING AXIS" in the axis direction specified by "MEASUREMENT DIREC.") is within this allowable range, the absence of errors is assumed, and no setting is performed in the calibration data.
Enter a numeric value.

- FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.

Processing when the OK range and the feedback range are 0

When the Ok range and the feedback range are set to 0, the processing below is performed.

<1> When both the OK range and the feedback are set to 0
The result of measurement is not set in the setting destination. Moreover, no alarm is issued as a result of measurement. (The result of measurement is just recorded in the measurement result list.)

<2> When the OK range is set to 0, and the feedback range is set to a nonzero value
If an error obtained from measurement is within the feedback range, the result of measurement is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.

<3> When the OK range is set to a nonzero value, and the feedback range is set to 0
An alarm is issued.

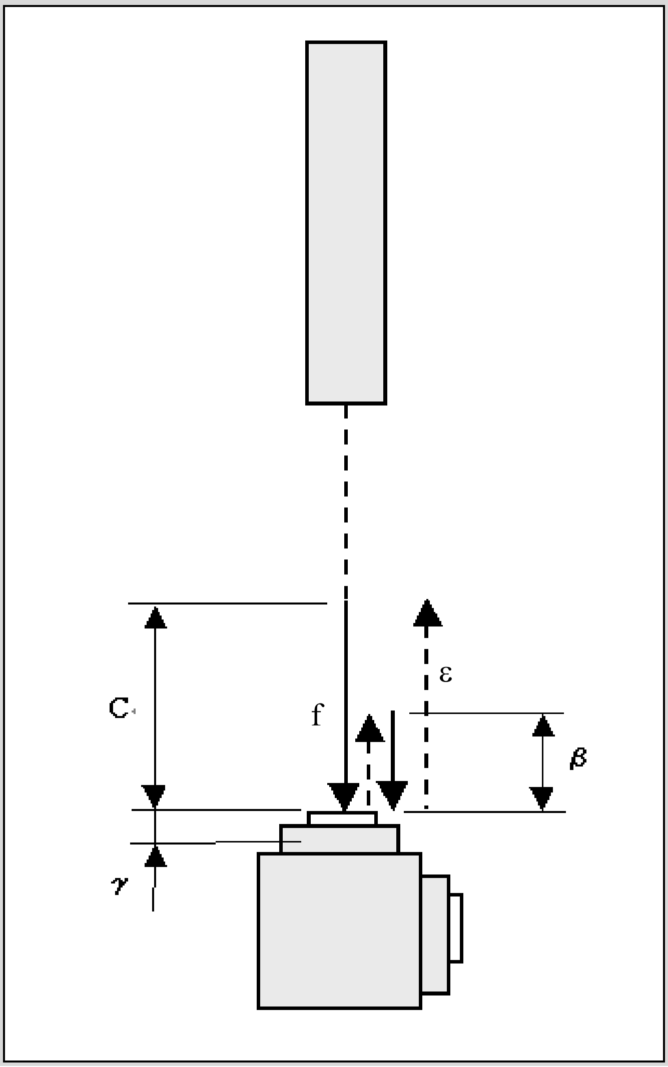
NOTE

When "ALL-AX" is selected in setting axis setting, an alarm is issued if the error of any one of the X coordinate, Y coordinate, and Z coordinate exceeds the feedback range. In this case, calibration data is not set even if other errors are within the feedback range.
If the error of any one of the X coordinate, Y coordinate, and Z coordinate is within the feedback range, calibration data is set. If the error of any other coordinate is within the OK range in this case, the calibration data of the data is not set.

Measurement motion

Measurement motion is described below.

- Measurement of the touch sensor position for measurement in the -Z-axis direction



<1> A rapid movement is made from the current position to the approach point (X coordinate,Y coordinate).
Here, the approach point (X coordinate,Y coordinate) represents the touch sensor position (Ax,Ay).

<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate).
Here, the approach point (Z coordinate) represents (touch sensor position Az + "CLEARANCE").

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)
Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

<4> Then, a rapid return movement is made by ε in the +Z-axis direction.

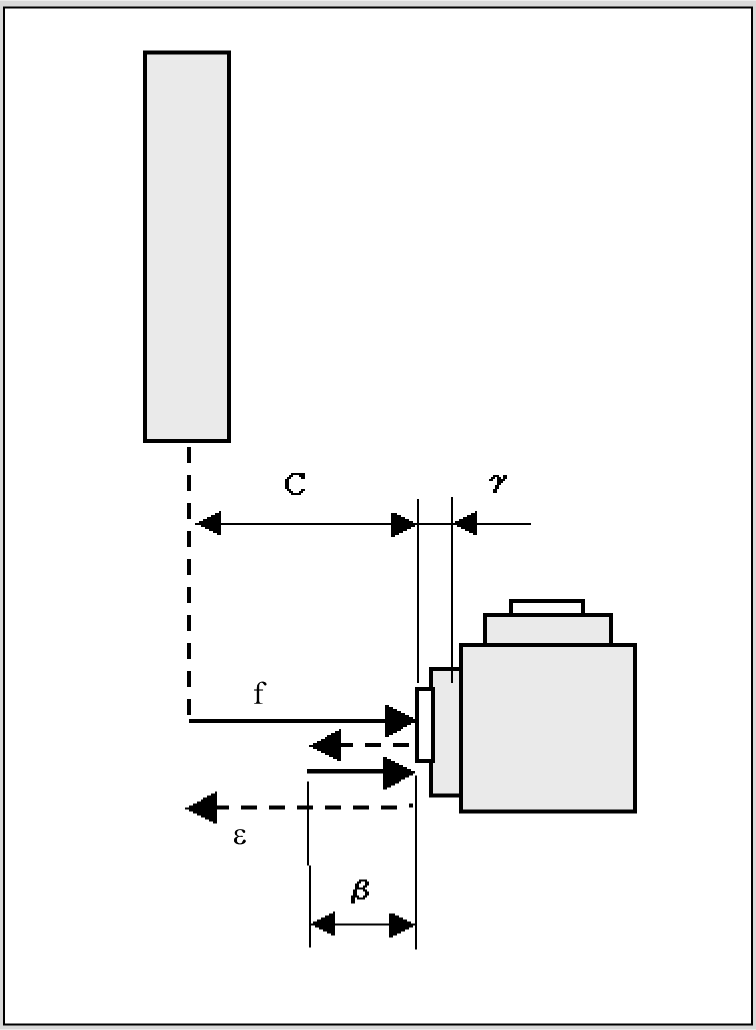
The symbols used above have the following meanings:

A: Touch sensor position. If "SETTIN" is selected in "SPECIFY OF MEAS. PT.", A represents the "sensor position for measurement in the -Z direction" of the touch sensor position in the specified measurement condition. If "INPUT" is selected in "SPECIFY OF MEAS. PT.", A represents the coordinates specified by "MEASURE POINT X", "MEASURE POINT Y", and "MEASURE POINT Z".

Ax: X coordinate of the touch sensor position above

Ay: Y coordinate of the touch sensor position above
Az: Z coordinate of the touch sensor position above
f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

- Measurement of the touch sensor position for measurement in the +X-axis direction



<1> A rapid movement is made from the current position to the approach point (X coordinate,Y coordinate).
Here, the approach point (X coordinate) represents (touch sensor position Ax - "CLEARANCE"). The approach point (Y coordinate) represents the touch sensor position Ay.
<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate).
The approach point (Z coordinate) represents the touch sensor position Az.
<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)
<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)
<5> Then, a rapid return movement is made by ε in the -X-axis direction.

- Measurement of the touch sensor position for measurement in the -X-axis direction

<1> A rapid movement is made from the current position to the approach point (X coordinate,Y coordinate).
Here, the approach point (X coordinate) represents (touch sensor position Ax + "CLEARANCE"). The approach point (Y coordinate) represents the touch sensor position Ay.
<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate).
The approach point (Z coordinate) represents the touch sensor position Az.
<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)
<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)
<5> Then, a rapid return movement is made by ε in the +X-axis direction.

- Measurement of the touch sensor position for measurement in the +Y-axis direction

<1> A rapid movement is made from the current position to the approach point (X coordinate,Y coordinate).
Here, the approach point (X coordinate) represents the touch sensor position Ax. The approach point (Y coordinate) represents (touch sensor position Ay - "CLEARANCE").
<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate).
The approach point (Z coordinate) represents the touch sensor position Az.
<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)
<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)
<5> Then, a rapid return movement is made by ε in the -Y-axis direction.

- Measurement of the touch sensor position for measurement in the -Y-axis direction

<1> A rapid movement is made from the current position to the approach point (X coordinate,Y coordinate).
Here, the approach point (X coordinate) represents the touch sensor position Ax. The approach point (Y coordinate) represents (touch sensor position Ay + "CLEARANCE").
<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate).
The approach point (Z coordinate) represents the touch sensor position Az.
<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)
<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)
<5> Then, a rapid return movement is made by ε in the +Y-axis direction.

G code format

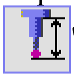
When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2000 P_ Q_ B_ R_ K_ H_ V_ L_ C_ F_ W_ I_ S_ Y_ ;
```

Measurement result

When G2000 is executed, the result of measurement is output to macro variables for the result of measurement and as the touch sensor position in the calibration data of the specified measurement condition.

2.2.2 Probe Length Measurement

When the probe is oriented in the Z-axis direction, a probe length measurement is made.
Select  "PROBE LENGTH CALIBRATION (PROBE Z-AXIS)" on the [CALIBRATE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT COND.

Enter a measurement condition group number to be referenced at measurement time, by specifying a numeric value.

- REFER. WORK HEIGHT

Enter the height of a reference workpiece to be contacted by the probe, by specifying a numeric value.

- MEASURE POINT X, Y

Enter the X and Y coordinates of a measurement position by specifying numeric values.

- CLEARANCE

Enter the distance from the measurement start point to the top face of a reference workpiece by specifying a numeric value.

- MOVING MEAS. SPEED

Enter a feedrate for measurement by specifying a numeric value.

[SETTING] tab

- OK RANGE (±)

Enter an allowable range of errors obtained from measurement, by specifying a numeric value.
If the difference between the obtained result of measurement and the probe length of the calibration data currently specified with "MEASUREMENT COND." is within this allowable range, the absence of errors is assumed, and no setting is performed in the calibration data.

- FEED BACK RANGE (±)

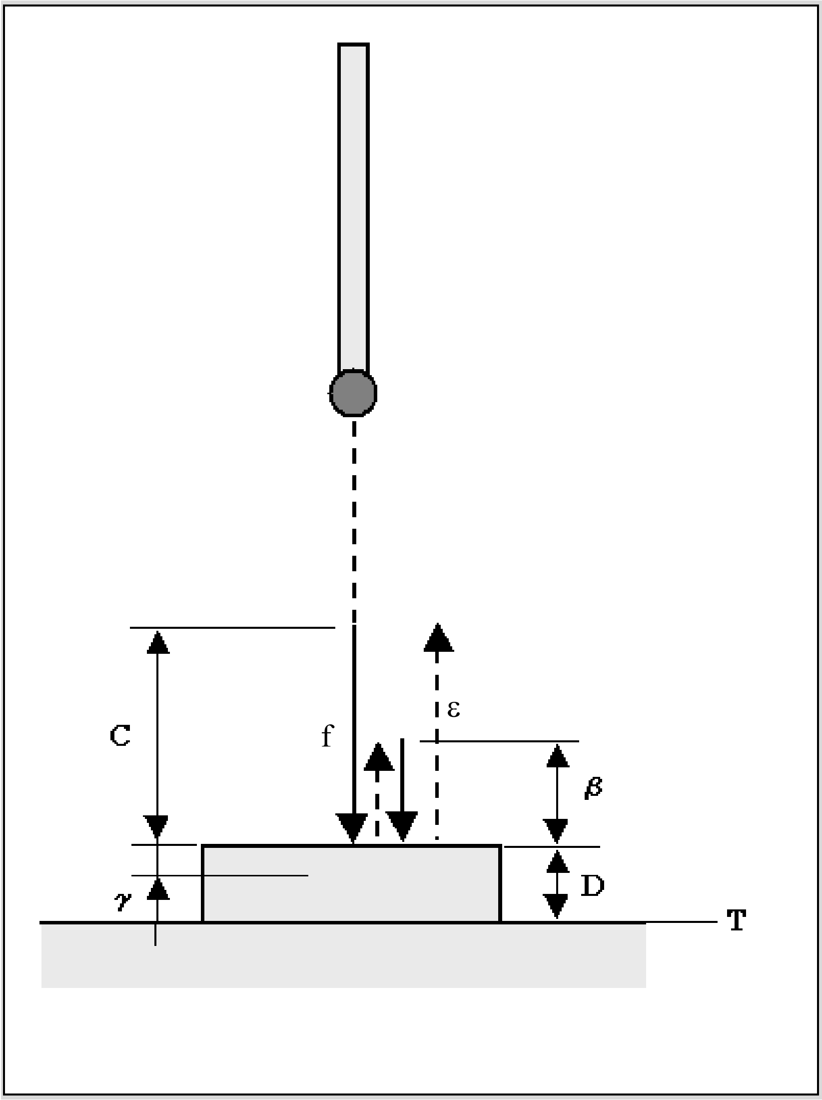
If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.

Processing when the OK range and the feedback range are 0

The same processing as for "Touch Sensor Position Measurement" is performed
.

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by "MEASURE POINT X" and "MEASURE POINT Y".

<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate).
Here, the approach point (Z coordinate) represents (T + "REFER. WORK HEIGHT " + "CLEARANCE").

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the feedrate F specified by "MOVING MEAS. SPEED". (Second measurement)

<5> Then, a rapid return movement is made by ε in the +Z-axis direction.

The symbols used above have the following meanings:

T: Height of the surface on which the reference workpiece is placed. ("Machine coordinate of the table surface when a measurement is made in the Z-axis direction" in the measurement condition is referenced.)

f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

G code format

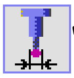
When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2001 Q_ D_ H_ V_ C_ F_ S_ Y_ ;

Measurement result

When G2001 is executed, the result of measurement is output to macro variables for the result of measurement and as the probe length in the calibration data of the specified measurement condition.

2.2.3 Stylus Ball Diameter Measurement

The diameters of the stylus ball in the X-axis direction and Y-axis direction are measured.
Make a measurement on the XY plane.
Select  "STYLUS BALL DIAMETER CALIBRATION(PROBE Z-AXIS)" on the [CALIBRATE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT COND.

Enter a measurement condition group number to be referenced at measurement time, by specifying a numeric value.
The result of measurement is set as calibration data of the group number specified here.

- BASE WORK RADIUS

Enter the diameter of a reference workpiece by specifying a numeric value.

- APROCH CENTER PT. X, Y

Enter the X and Y coordinates of the measurement start point by specifying numeric values.
Enter the coordinates of the center of the reference workpiece.

- HEIGHT OF MEAS. PT.

Enter the height of a measurement position in the Z-axis direction by specifying a numeric value.

- APROCH DISTANCE

Enter the move distance from the approach point to a measurement position in the Z-axis direction by specifying a numeric value.

- MOVING MEAS. SPEED

Enter a feedrate for measurement by specifying a numeric value.

- MEASUREMENT POINT

Enter the number of measurement points by specifying a numeric value (1 to 4).
When no value is entered, 4 (four-point measurement) is assumed.

[SETTING] tab

- OK RANGE (±)

Enter an allowable range of errors obtained from measurement, by specifying a numeric value.
If the difference between the stylus ball diameter obtained as a result of measurement and the stylus ball diameter currently set in the calibration data specified with "MEASUREMENT COND." is within this allowable range, the absence of errors is assumed, and no setting is performed in the calibration data.

- FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.

NOTE

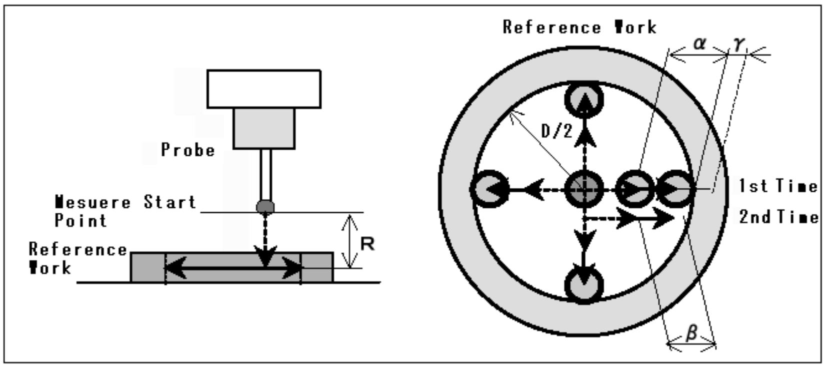
Two stylus ball diameters are set in the calibration data: one in the first axis direction, and the other in the second axis direction. So, the diameter values obtained from measurement are compared in the two directions.
If one of the diameters exceeds the feedback range, an alarm is issued, and no setting is performed in the calibration data.
If one of the two diameters exceeds the OK range, and is within the feedback range, and the other is within the OK range, the former measurement result only is set in the calibration data.

Processing when the OK range and the feedback range are 0

The same processing as for "Touch Sensor Position Measurement" is performed.

Measurement motion

Measurement motion is described below.



<1> The reference workpiece is placed on the table, then this measurement cycle is executed.
<2> When this measurement cycle is executed, a rapid movement is first made from the current position to the point specified by ("APROCH CENTER PT.X" + ("BASE WORK RADIUS"/2 - α - stylus radius r)) in the X-axis direction and by "APROCH CENTER PT.Y" in the Y-axis direction.
<3> A rapid movement is made in the -Z-axis direction to the point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<4> A movement is made in the -Z-axis direction to a point of "HEIGHT OF MEAS. PT." at feedrate fb.
<5> In the range (α + γ), a measurement is made in the +X-axis direction at feedrate f. (First measurement)
<6> After a rapid return movement is made by β, a rapid movement is made to the X coordinate specified by "APROCH CENTER PT.X", then a movement is made at feedrate fa in the -X-axis direction by the distance ("BASE WORK RADIUS D"/2 - α - stylus radius r).
<7> A similar measurement is made in the -X-axis direction and ±Y-axis directions.
<8> After the first measurement, a center position for the second measurement is calculated from the measurement result of each point.

<9> In the +X-axis direction, a movement is made at feedrate fa to the position (measurement position of the first measurement - β), then a measurement is made at the input feedrate "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<10>A similar measurement is made in the -X-axis direction and ±Y-axis directions.
<11>A return movement is made by "APROCH DISTANCE" in the Z-axis direction.

When bit 3 (SHRT) of parameter No. 12380 = 1
<1> The reference workpiece is placed on the table, then this measurement cycle is executed.
<2> When this measurement cycle is executed, a rapid movement is first made from the current position to the point specified by ("APROCH CENTER PT.X" + ("BASE WORK RADIUS"/2 - α - stylus radius r)) in the X-axis direction and by "APROCH CENTER PT.Y" in the Y-axis direction.
<3> A rapid movement is made in the -Z-axis direction to the point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<4> A movement is made in the -Z-axis direction to a point of "HEIGHT OF MEAS. PT." at feedrate fb.
<5> In the range (α + γ), a movement is made in the +X-axis direction at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<7> After a rapid return movement is made by ε, a rapid movement is made to the X coordinate specified by "APROCH CENTER PT.X", then a movement is made at feedrate fa in the -X-axis direction by the distance ("BASE WORK RADIUS D"/2 - α - stylus radius r).
<8> A similar measurement is made in the -X-axis direction and ±Y-axis directions.
<9> A return movement is made by "APROCH DISTANCE" in the Z-axis direction.

The symbols used above have the following meanings:
fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.
fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."
f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
α: Value of “APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

Motion depending on the number of measurement points

When "MEASUREMENT POINT" is set to 1, a measurement is made in the +X-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +X-axis and -X-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +X-axis, -X-axis, and +Y-axis directions only.

When bit 0 (CRY) of parameter No. 12380 is set to 1, however, a measurement is made as follows:
When "MEASUREMENT POINT" is set to 1, a measurement is made in the +Y-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +Y-axis and -Y-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +Y-axis, -Y-axis, and +X-axis directions only.

G code format

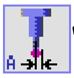
When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2002 Q_ D_ H_ V_ L_ R_ F_ P_ S_ Y_ ;

Measurement result

When G2002 is executed, the diameters of the stylus ball in the X-axis and Y-axis directions are found from the measured values and are output to the calibration data and macro variables for the result of measurement.

2.2.4 Stylus Ball Center Offset Measurement-A

The offset between the center of the stylus ball and the center of the spindle is measured.
Make a measurement on the XY plane.
Select  "STYLUS OFFSETS CALIBRATION-A (PROBE Z-AXIS)" on the [CALIBRATE] tab of the measurement cycle menu screen. The input screen appears.

NOTE
By using a function such as the spindle orientation function, the machine tool builder needs to make a preparation beforehand to enable the spindle to be positioned at 0° and 180° with a miscellaneous function (M code).

[MOTION] tab

- MEASUREMENT COND.

Enter a measurement condition group number to be referenced at measurement time, by specifying a numeric value.
The result of measurement is set as calibration data of the group number specified here.

- BASE WORK RADIUS

Enter the diameter of a reference workpiece by specifying a numeric value.

- APROCH CENTER PT. X, Y

Enter the X and Y coordinates of the measurement start point by specifying numeric values.
Usually, enter the coordinates of the center of the reference workpiece.

- HEIGHT OF MEAS. PT.

Enter the height of a measurement position in the Z-axis direction by specifying a numeric value.

- APROCH DISTANCE

Enter the move distance from the approach point to a measurement position in the Z-axis direction by specifying a numeric value.

- MOVING MEAS. SPEED

Enter a feedrate for measurement by specifying a numeric value.

- MEASUREMENT POINT

Enter the number of measurement points by specifying a numeric value (1 to 4).
When no value is entered, 4 (four-point measurement) is assumed.

[SETTING] tab

- OK RANGE (±)

Enter an allowable range of offset values obtained from measurement, by specifying a numeric value.
If an offset obtained as the result of measurement is within this range, the absence of offsets is assumed, and the offset at the setting destination is cleared to 0.

- FEED BACK RANGE (±)

If an offset obtained from measurement is not within the OK range but is within this feedback range, the offset is set in the setting destination.
If an offset obtained from measurement exceeds the feedback range, an alarm is issued.

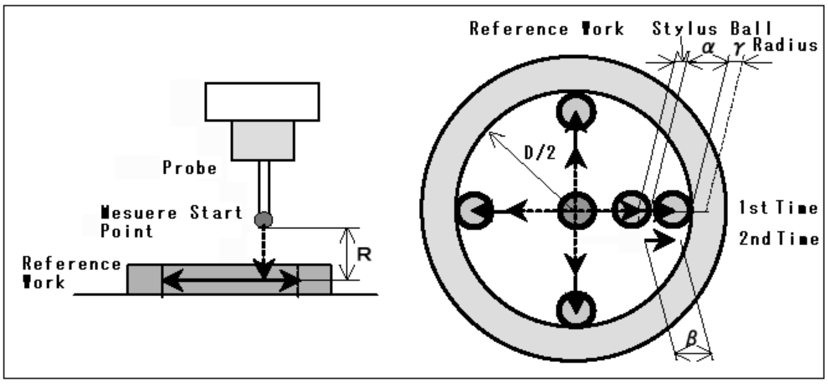
> **NOTE**
> Two stylus ball offsets are set in the calibration data: one in the first axis direction, and the other in the second axis direction. So, the offsets obtained from measurement are compared in the two directions.
> If one of the offsets exceeds the feedback range, an alarm is issued, and no setting is performed in the calibration data.
> If one of the two offsets exceeds the OK range, and is within the feedback range, and the other is within the OK range, the former measurement result only is set in the calibration data.

Processing when the OK range and the feedback range are 0

The same processing as for "Touch Sensor Position Measurement" is performed.

Measurement motion

Measurement motion is described below.



<1> The reference workpiece is placed on the table, then this measurement cycle is executed.
<2> When this measurement cycle is executed, a rapid movement is first made from the current position to the point specified by ("APROCH CENTER PT.X" + ("BASE WORK RADIUS D"/2 - α - stylus radius r)) in the X-axis direction and by "APROCH CENTER PT.Y" in the Y-axis direction.
<3> A rapid movement is made in the -Z-axis direction to the point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<4> A movement is made in the -Z-axis direction to a point of "HEIGHT OF MEAS. PT." at feedrate fb.
<5> After 0-degree spindle orientation is executed, a measurement is made in the +X-axis direction in the range (α + γ) at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<7> Next, a rapid return movement is made by β, and 180-degree spindle orientation is executed, then a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)

<8> After a rapid return movement is made by ε, a rapid movement is made to the X coordinate specified by "APROCH CENTER PT.X", then a movement is made at feedrate fa in the -X-axis direction by the distance ("BASE WORK RADIUS D"/2 - α - stylus radius r).
<9> A similar measurement is made in the -X-axis direction and ±Y-axis directions.
<10>A return movement is made by "APROCH DISTANCE" in the Z-axis direction.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of “APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

Motion depending on the number of measurement points

When "MEASUREMENT POINT" is set to 1, a measurement is made in the +X-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +X-axis and -X-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +X-axis, -X-axis, and +Y-axis directions only.

Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.
When "MEASUREMENT POINT" is set to 1, a measurement is made in the +Y-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +Y-axis and –Y-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +Y-axis, -Y-axis, and +X-axis directions only.

G code format

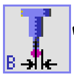
When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2003 Q_ D_ H_ V_ L_ R_ F_ P_ S_ Y_ ;
```

Measurement result

When G2003 is executed, center offsets of the stylus ball in the X-axis and Y-axis directions are found from measured values, and are output to the calibration data and macro variables for the result of measurement.

2.2.5 Stylus Ball Center Offset Measurement-B

The offset between the center of the stylus ball and the center of the spindle is measured.
Make a measurement on the XY plane.
Select  "STYLUS OFFSETS CALIBRATION-B(PROBE Z-AXIS)" on the [CALIBRATE] tab of the measurement cycle menu screen. The input screen appears.

> **NOTE**
> The center of a reference workpiece needs to be placed accurately at a table position whose coordinates are known.

[MOTION] tab

- MEASUREMENT COND.
Enter a measurement condition group number to be referenced at measurement time, by specifying a numeric value.
The result of measurement is set as calibration data of the group number specified here.

- BASE WORK RADIUS
Enter the diameter of a reference workpiece by specifying a numeric value.

- APROCH CENTER PT. X
Enter the X coordinate of the center of a reference workpiece by specifying a numeric value.

- APROCH CENTER PT. Y
Enter the Y coordinate of the center of a reference workpiece by specifying a numeric value.

- HEIGHT OF MEAS. PT.
Enter the height of a measurement position in the Z-axis direction by specifying a numeric value.

- APROCH DISTANCE
Enter the move distance from the approach point to a measurement position in the Z-axis direction by specifying a numeric value.

- MOVING MEAS. SPEED
Enter a feedrate for measurement by specifying a numeric value.

- MEASUREMENT POINT
Enter the number of measurement points by specifying a numeric value (1 to 4).
When no value is entered, 4 (four-point measurement) is assumed.

[SETTING] screen

- OK RANGE (±)
Enter an allowable range of offset values obtained from measurement, by specifying a numeric value.
If an offset obtained as the result of measurement is within this range, the absence of offsets is assumed, and the offset at the setting destination is cleared to 0.

- FEED BACK RANGE (±)
If an offset obtained from measurement is not within the OK range but is within this feedback range, the offset is set in the setting destination.
If an offset obtained from measurement exceeds the feedback range, an alarm is issued.

NOTE

Two stylus ball offsets are set in the calibration data: one in the first axis direction, and the other in the second axis direction. So, the offsets obtained from measurement are compared in the two directions.
If one of the offsets exceeds the feedback range, an alarm is issued, and no setting is performed in the calibration data.
If one of the two offsets exceeds the OK range, and is within the feedback range, and the other is within the OK range, the former measurement result only is set in the calibration data.

Processing when the OK range and the feedback range are 0

When the OK range and the feedback range are set to 0, the processing below is performed.

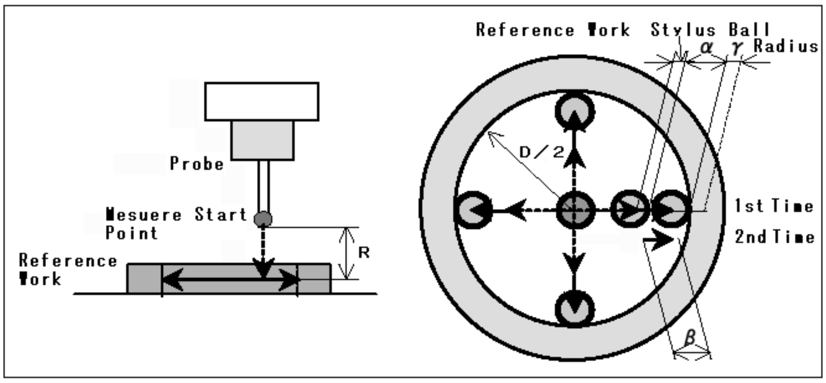
<1> When both the OK range and the feedback are set to 0
The result of measurement is not set in the setting destination. Moreover, no alarm is issued as a result of measurement. (The result of measurement is just recorded in the measurement result list.)

<2> When the OK range is set to 0, and the feedback range is set to a nonzero value
If an error obtained from measurement is within the feedback range, the result of measurement is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.

<3> When the OK range is set to a nonzero value, and the feedback range is set to 0
An alarm is issued.

Measurement motion

Measurement motion is described below.



<1> The reference workpiece is placed on the table, then this measurement cycle is executed.

<2> When this measurement cycle is executed, a rapid movement is first made from the current position to the point specified by ("APROCH CENTER PT.X" + ("BASE WORK RADIUS"/2 - α - stylus radius r)) in the X-axis direction and by "APROCH CENTER PT.Y" in the Y-axis direction.

<3> A rapid movement is made in the -Z-axis direction to the point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<4> A movement is made in the -Z-axis direction to a point of "HEIGHT OF MEAS. PT." at feedrate fb.

<5> In the range (α + γ), a movement is made in the +X-axis direction at feedrate f. (First measurement)

<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)

<7> After a rapid return movement is made by ε, a rapid movement is made to the X coordinate specified by "APROCH CENTER PT.X", then a movement is made at feedrate fa in the -X-axis direction by the distance ("BASE WORK RADIUS D"/2 - α - stylus radius r).

<8> A similar measurement is made in the -X-axis direction and ±Y-axis directions.

<9> A return movement is made by "APROCH DISTANCE" in the Z-axis direction.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND.

α: Value of "APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

Motion depending on the number of measurement points

When "MEASUREMENT POINT" is set to 1, a measurement is made in the +X-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +X-axis and -X-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +X-axis, -X-axis, and +Y-axis directions only.

Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.
When "MEASUREMENT POINT" is set to 1, a measurement is made in the +Y-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +Y-axis and –Y-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +Y-axis, -Y-axis, and +X-axis directions only.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2004 Q_ D_ H_ V_ L_ R_ F_ P_ S_ Y_ ;

Measurement result

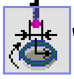
When G2004 is executed, center offsets of the stylus ball in the X-axis and Y-axis directions are found from entered center X and Y coordinates and measured values, and are output to the calibration data and macro variables for the result of measurement.

2.2.6 Stylus Ball Diameter Measurement (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the diameter of the stylus ball is obtained from the average of the results.

NOTE
This function is enabled when bit 1 (RST) of parameter No. 27222 is set to 1.

[MOTION] tab

Select  "STYLUS BALL DIA, CALIB.-WORK ROTATION (PROBE Z)" on the [CALIBRATE] tab of the measurement cycle menu screen. The measurement operation setting screen appears.

- MEASUREMENT COND.

Enter a measurement condition group number to be referenced at measurement time, by specifying a numeric value.

- BASE WORK RADIUS

Enter the diameter of a reference workpiece by specifying a numeric value.

- CENTER POINT X

Enter the X coordinate of the center of a circle by specifying a numeric value.

- CENTER POINT Y

Enter the Y coordinate of the center of a circle by specifying a numeric value.

- HEIGHT OF MEAS. PT.

Enter the height of a measurement position in the Z-axis direction by specifying a numeric value.

- APROCH DISTANCE

Enter the move distance from the approach point to a measurement position in the Z-axis direction by specifying a numeric value.

- STARTING ANGLE

Enter the positioning angle for measurement of the first point by specifying a numeric value. An angle satisfying "-360° < angle < 360°" may be specified.

- PITCH ANGLE

Enter the pitch angle between measurement points by specifying a numeric value. An angle satisfying "0° < angle < 360°" may be specified.
By default, "90" is displayed.

- MOVING MEAS. SPEED

Enter a feedrate for measurement by specifying a numeric value.

- MEASUREMENT POINT

Enter the number of measurement points by specifying a numeric value. Up to four points may be specified. This item may not be specified. If this item is not specified, measurements are made from "STARTING ANGLE" at intervals of "PITCH ANGLE" until 360° is reached.

Input screen for automatic calibration data setting

This screen enables measurement values to be set as calibration data.

- OK RANGE (±)

Specify an allowable range of errors obtained from measurement. If the difference between a stylus ball diameter obtained from measurement and the stylus ball diameter currently set as calibration data is within this range, the presence of no error is assumed, resulting in no setting as calibration data.

- FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination. If an error obtained from measurement exceeds the feedback range, an alarm is issued.

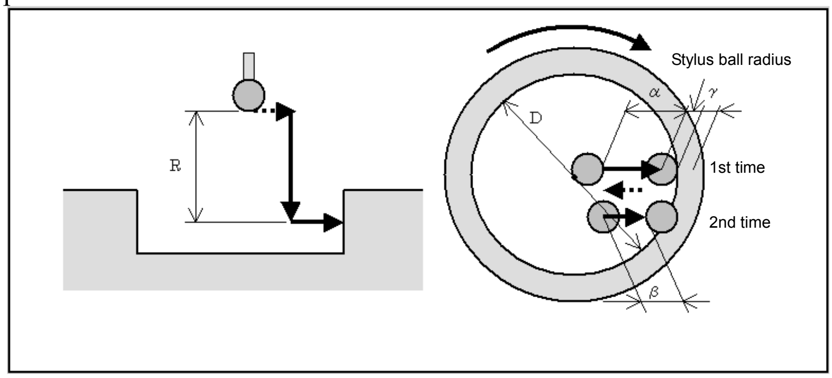
Processing when the OK range and the feedback range are 0

The same processing as for "STYLUS BALL DIAMETER CALIBRATION (PROBE Z-AXIS)" is performed.

Measurement motion

- When rotation axis positioning based on C-axis rotation is used

A measurement operation with the +X direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified by "STARTING ANGLE."

<2> A rapid movement is made from the current position to the point specified by ("CENTER POINT X"+("BASE WORK RADIUS"/2-α-r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction.

<3> A rapid movement is made in the Z-axis direction to the approach point ("HEIGHT OF MEAS.PT."+"APROCH DISTANCE").

<4> A movement is made in the -Z-axis direction to the position specified by "HEIGHT OF MEAS.PT." at feedrate fb.

<5> A measurement is made in the range (α + γ) at feedrate f. (First measurement)

<6> Next, a rapid return movement is made by β then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to (β + γ). (Second measurement)

<7> A rapid return movement is made to the approach point in the X-axis direction.

<8> The C-axis is rotated by the angle specified by "PITCH ANGLE."

<9> Steps <5> through <8> above are repeated as many times as specified by "MEASUREMENT POINT."

<10> Finally, a rapid return movement is made to the approach point along the Z-axis.

> **NOTE**
> Specify a measurement direction in parameter No. 27231.

Meaning	Symbol in the explanation
Feed-rate for approaching start point (in the axis direction)	fb
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Escaping distance for 2nd measurement	ε
Stylus ball diameter/2	r

> **NOTE**
> The values of α, β, γ, ε, fb, f are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

When rotation axis positioning based on the spindle orientation function is used

The same measurement procedure as for C-axis rotation is used, except that rotation axis positioning is performed using the spindle orientation function.
If the setting of "STARTING ANGLE" or "PITCH ANGLE" is improper so that the output of a spindle orientation M code for positioning at a proper angle is disabled, the alarm "CANNOT MOVE TO THE SPECIFIED ANGLE" is issued at program execution time.

> **NOTE**
> 1 Specify spindle orientation M codes in parameter No. 27240 through No. 27245.
> 2 When using the spindle orientation function, specify "90" or "120" in "PITCH ANGLE." In "STARTING ANGLE," specify an angle that matches the spindle orientation M codes specified in the parameters.
> 3 Specify bit 0 (SRO) of parameter No. 27223 to set whether to use C-axis positioning or the spindle orientation function for rotation axis positioning.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2005 Q_ D_ H_ V_ L_ R_ N_ M_ F_ P_

Measurement result

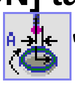
When G2005 is executed, the diameter of the stylus ball in the measurement direction is found from measured values and is output to the calibration data and macro variable for the result of measurement.

2.2.7 Stylus Ball Center Offset Measurement-A (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the center offset of the stylus ball is obtained from the average of the results.

> **NOTE**
> 1 This function is enabled when bit 1 (RST) of parameter No. 27222 is set to 1.
> 2 By using a function such as the spindle orientation function, the machine tool builder needs to position the spindle at 0° and 180° (probe axis) with a miscellaneous function (M code).

[MOTION] tab

Select  "STYLUS OFFSETS CALIB.-A-WORK ROTATION (PROBE Z)" on the [CALIBRATE] tab of the measurement cycle menu screen. The measurement operation setting screen appears.
The information displayed in each input item and operation are the same as for "STYLUS BALL DIA, CALIB.-WORK ROTATION (PROBE Z)."

Input screen for automatic calibration data setting

This screen enables measurement values to be set as calibration data.

- OK RANGE (±)

Specify an allowable range of errors obtained from measurement. If an offset value obtained from measurement is within this range, the presence of no offset is assumed, and the offset value set in the setting destination is cleared to 0. Enter a numeric value.

- FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination. If an error obtained from measurement exceeds the feedback range, an alarm is issued. Enter a numeric value.

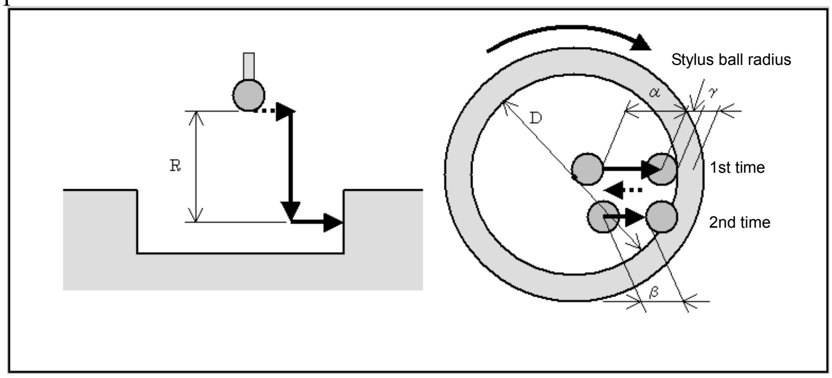
Processing when the OK range and the feedback range are 0

The same processing as for "STYLUS OFFSETS CALIBRATION-A" is performed.

Measurement motion

- When rotation axis positioning based on C-axis rotation is used

A measurement operation with the +X direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified by “STARTING ANGLE.”
<2> A rapid movement is made from the current position to the point specified by ("CENTER POINT X"+("BASE WORK RADIUS"/2-α-r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<3> A rapid movement is made in the Z-axis direction to the approach point (“HEIGHT OF MEAS.PT.”+”APROCH DISTANCE”).
<4> A movement is made in the -Z-axis direction to the position specified by “HEIGHT OF MEAS.PT.” at feedrate fb.
<5> After 0-degree spindle orientation (probe axis) is executed, a measurement is made in the range (α + γ) at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to (β + γ). (Second measurement)
<7> A rapid return movement is further made by β, and 180-degree spindle orientation (probe axis) is executed, then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to (β + γ). (Third measurement)
<8> A rapid return movement is made to the approach point in the X-axis direction.
<9> The C-axis is rotated by the angle specified by “PITCH ANGLE.”
<10> Steps <5> through <9> above are repeated as many times as specified by "MEASUREMENT POINT."
<11> Finally, a rapid return movement is made to the approach point along the Z-axis.

NOTE
Specify a measurement direction in parameter No. 27231.

Meaning	Symbol in the explanation
Feed-rate for approaching start point (in the axis direction)	fb
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Escaping distance for 2nd measurement	ε
Stylus ball diameter/2	r

NOTE
The values of α, β, γ, ε, fb, f are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

- When rotation axis positioning based on the spindle orientation function is used

The same processing as for "STYLUS BALL DIA, CALIB.-WORK ROTATION (PROBE Z)" is performed.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2006 Q_ D_ H_ V_ L_ R_ N_ M_ F_ P_

Measurement result

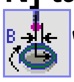
When G2006 is executed, the center offset of the stylus ball in the measurement direction is found from measured values and is output to the calibration data and macro variable for the result of measurement.

2.2.8 Stylus Ball Center Offset Measurement-B (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the center offset of the stylus ball is obtained from the average of the results.

NOTE
This function is enabled when bit 1 (RST) of parameter No. 27222 is set to 1.

[MOTION] tab

Select  "STYLUS OFFSETS CALIB.-B-WORK ROTATION (PROBE Z)" on the [CALIBRATE] tab of the measurement cycle menu screen. The measurement operation setting screen appears.
The information displayed in each input item and operation are the same as for "STYLUS BALL DIA, CALIB.-WORK ROTATION (PROBE Z)."

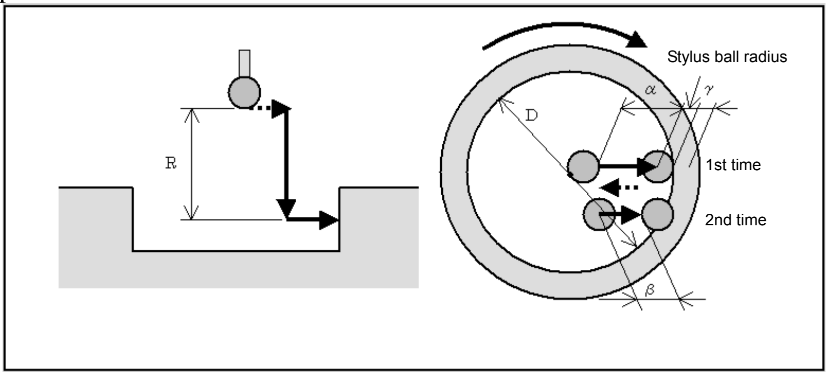
Input screen for automatic calibration data setting

This screen enables measurement values to be set as calibration data.
The information displayed in each input item and operation are the same as for "STYLUS OFFSETS CALIB.-A-WORK ROTATION (PROBE Z)."

Measurement motion

- When rotation axis positioning based on C-axis rotation is used

A measurement operation with the +X direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified by “STARTING ANGLE.”
<2> A rapid movement is made from the current position to the point specified by ("CENTER POINT X"+("BASE WORK RADIUS"/2-α-r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<3> A rapid movement is made in the Z-axis direction to the approach point ("HEIGHT OF MEAS.PT."+"APROCH DISTANCE").
<4> A movement is made in the -Z-axis direction to the position specified by “HEIGHT OF MEAS.PT.” at feedrate fb.
<5> A measurement is made in the range ($\alpha + \gamma$) at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to ($\beta + \gamma$). (Second measurement)
<7> A rapid return movement is made to the approach point in the X-axis direction.
<8> The C-axis is rotated by the angle specified by “PITCH ANGLE.”
<9> Steps <5> through <8> above are repeated as many times as specified by “MEASUREMENT POINT.”
<10> Finally, a rapid return movement is made to the approach point along the Z-axis.

> **NOTE**
> Specify a measurement direction in parameter No. 27231.

Meaning	Symbol in the explanation
Feed-rate for approaching start point (in the axis direction)	fb
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Escaping distance for 2nd measurement	ε
Stylus ball diameter/2	r

> **NOTE**
> The values of α, β, γ, ε, fb, f are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

- When rotation axis positioning based on the spindle orientation function is used

The same processing as for "STYLUS BALL DIA, CALIB.-WORK ROTATION (PROBE Z)" is performed.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2007 Q_ D_ H_ V_ L_ R_ N_ M_ F_ P_ S_ Y_ ;
```

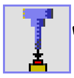
Measurement result

When G2007 is executed, the center offset of the stylus ball in the measurement direction is found from the input value of "CENTER PT." in the measurement direction and measured values and is output to the calibration data and macro variable for the result of measurement.

2.3 TOOL MEASUREMENT (TOOL Z-AXIS DIRECTION)

2.3.1 Milling Tool Measurement

When the milling tool is oriented in the Z-axis direction, its figures in the tool length direction and tool radius direction are measured.

Select  "MILLING TOOL MEASUREMENT (TOOL Z-AXIS)" on the [TOOL MESUR] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT METH.

Select a measurement axis direction from the soft keys.

- MEASUREMENT COND.

Enter a measurement condition group number to be referenced at measurement time, by specifying a numeric value.

- CLEARANCE

Enter the distance from the position of the touch sensor to the measurement start point by specifying a numeric value.

- MOVING MEAS. SPEED

Enter a feedrate for measurement by specifying a numeric value.

- SPECIFY OF X SHIFT

Select a method of specifying the shift amount from the X coordinate of the position of the touch sensor for tool measurement to the X coordinate of the tool measurement position, from the soft keys.
By default, [AUTO] is selected.
When [AUTO] is selected, the approach position in the X-axis direction at the time of tool measurement is automatically determined by referencing the tool offset value. (For details, see "Measurement motion" described later.)
When [OFSET+] or [OFSET-] is selected, the tool to be measured is approached at the position shifted by the specified tool offset value from the X coordinate of the touch sensor position. [OFSET+] makes a shift in the + direction. [OFSET-] makes a shift in the - direction.
When [INPUT+] or [INPUT-] is selected, the tool is approached at the position shifted by the value input in the next item "OFFSET/DIFFERENCE X" from the X coordinate of the touch sensor position.
When [DIFF+] or [DIFF-] is selected, the tool is approached at the position shifted by the specified tool offset value added to the value specified by the next item "OFFSET/DIFFERENCE X" from the X coordinate of the touch sensor position.

- OFFSET/DIFFERENCE X

This item is displayed when [INPUT+], [INPUT-], [DIFF+], or [DIFF-] is selected in "SPECIFY OF X SHIFT".
When [INPUT+] or [INPUT-] is selected, enter the shift amount from the X coordinate of the touch sensor position for tool measurement to the X coordinate of the tool measurement position.
When [DIFF+] or [DIFF-] is selected, enter a value so that the tool offset value added to the value specified by this item is the shift amount from the X coordinate of the touch sensor position for tool measurement to the X coordinate of the tool measurement position.

- SPECIFY OF Y SHIFT, SPECIFY OF Z SHIFT

Same as "SPECIFY OF X SHIFT"

- OFFSET/DIFFERENCE Y, OFFSET/DIFFERENCE Z

Same as "OFFSET/DIFFERENCE X"

[T-TOOL] tab

This screen is the input screen (for turning) used for automatic tool offset setting.
This screen enables specification for setting a measured value as a tool offset value on the turning side.

> **NOTE**
> With the CNC for a machining center, the [T-TOOL] tab is not displayed.

- COMP. NUMBER T

Enter a tool offset number for measurement result setting by specifying a numeric value.
Otherwise, the result of measurement is not set as a tool offset value.

> **NOTE**
> "32 tool compensation sets", "64 tool compensation sets", "99 tool compensation sets", "400 tool compensation sets", and "999 tool compensation sets" are optional.

- SETTING DEST. (T)

Select a tool offset item for storing the result of measurement, from the soft keys.

> **NOTE**
> When the tool geometry and wear compensation options are enabled, and a compensation value obtained from measurement is set as a tool geometry compensation value, the tool wear compensation value is set to 0. When a compensation value obtained from measurement is set as a tool wear compensation value, the differential between the original tool geometry compensation value and the compensation value obtained from measurement is set.

- OK RANGE (±)

Enter an allowable range of errors obtained from measurement, by specifying a numeric value.
If the difference between the obtained result of measurement and the currently set offset value (sum of a geometry compensation value and wear compensation value) is within this allowable range, the absence of errors is assumed, and no setting is performed in the calibration data.

- FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.

OK RANGE AND FEEDBACK RANGE COMPARISON TARGET

If a value other than [INPUT+] and [INPUT-] is entered in "SPECIFY OF X, Y, or Z SHIFT", a decision is made by comparing the offset value currently set as the tool offset value with the result of measurement.

If [INPUT+] or [INPUT-] is entered in "SPECIFY OF X, Y, or Z SHIFT", a decision is made by comparing the value entered in "OFFSET/DIFFERENCE X, Y or Z" with the result of measurement.

> **NOTE**
> In order to set the result of measurement as the tool offset value at all times, enter 0 in OK RANGE, and enter a sufficiently large value in FEED BACK RANGE.

Processing when the OK range and the feedback range are 0

When the Ok range and the feedback range are set to 0, the processing below is performed.

<1> When both the OK range and the feedback are set to 0
The result of measurement is not set in the setting destination. Moreover, no alarm is issued as a result of measurement. (The result of measurement is just recorded in the measurement result list.)

<2> When the OK range is set to 0, and the feedback range is set to a nonzero value
If an error obtained from measurement is within the feedback range, the result of measurement is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.

<3> When the OK range is set to a nonzero value, and the feedback range is set to 0
An alarm is issued.

[M-TOOL] tab

This screen is the input screen (for milling) used for automatic tool offset setting.
This screen enables specification for setting a measured value as a tool offset value on the milling side.

> **NOTE**
> With the CNC for a lathe, the [M-TOOL] tab is not displayed.

- SETTING DEST. (M)

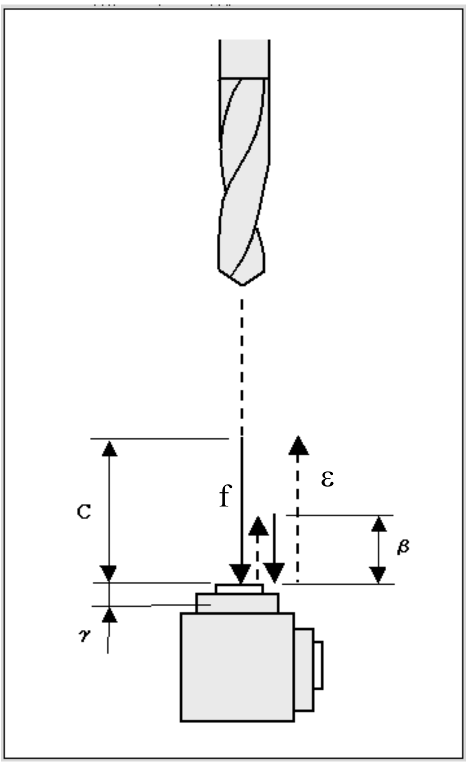
Select a tool offset item for storing the result of measurement, from the soft keys.

The contents of the other items are the same as for the [T-TOOL] tab described earlier.

Measurement motion

Measurement motion is described below.

- Measurement of an offset value in the -Z-axis direction (measurement of an offset value in the tool length direction) - When [AUTO] is selected in "SPECIFY OF X, Y, and Z SHIFT"



The measurement motion described below is made when [AUTO] is selected in all input items of "SPECIFY OF X SHIFT", "SPECIFY OF Y SHIFT", and "SPECIFY OF Z SHIFT".

<1> A rapid movement is made from the current position to the approach point (X coordinate,Y coordinate).
Here, the approach point (X coordinate,Y coordinate) represents the X and Y coordinates of the "sensor position for measurement in the -Z direction" of the touch sensor position in the specified measurement condition.

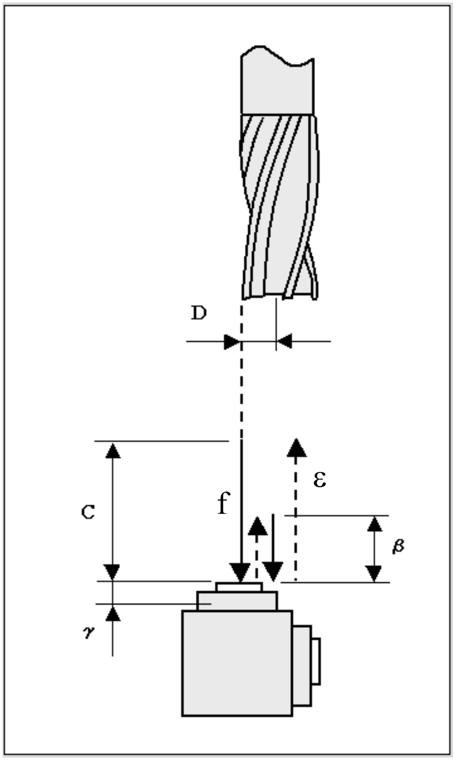
<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate).
Here, the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position in the specified measurement condition + "CLEARANCE" + OFS_H).

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

<5> Then, a rapid return movement is made by ε in the +Z-axis direction.

- Measurement of an offset value in the -Z-axis direction (measurement of an offset value in the tool length direction) - When a soft key other than [AUTO] is selected in "SPECIFY OF X, Y, and Z SHIFT"



If the X coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position is shifted from the X coordinate of the tool measurement position as shown below, specify the shift amount in "SPECIFY OF X SHIFT".

For example, the motion described below is made when [OFSET+] is selected in "SPECIFY OF X SHIFT". (It is assumed that [AUTO] is selected for the Y-axis direction and the Z-axis direction.)

<1> A rapid movement is made from the current position to approach point (X coordinate, Y coordinate). Here, the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position in the specified measurement condition + OFS_D). The approach point (Y coordinate) represents the Y coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position in the specified measurement condition.

<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate). Here, the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position in the specified measurement condition + "CLEARANCE" + OFS_H).

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to ($\beta + \gamma$) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

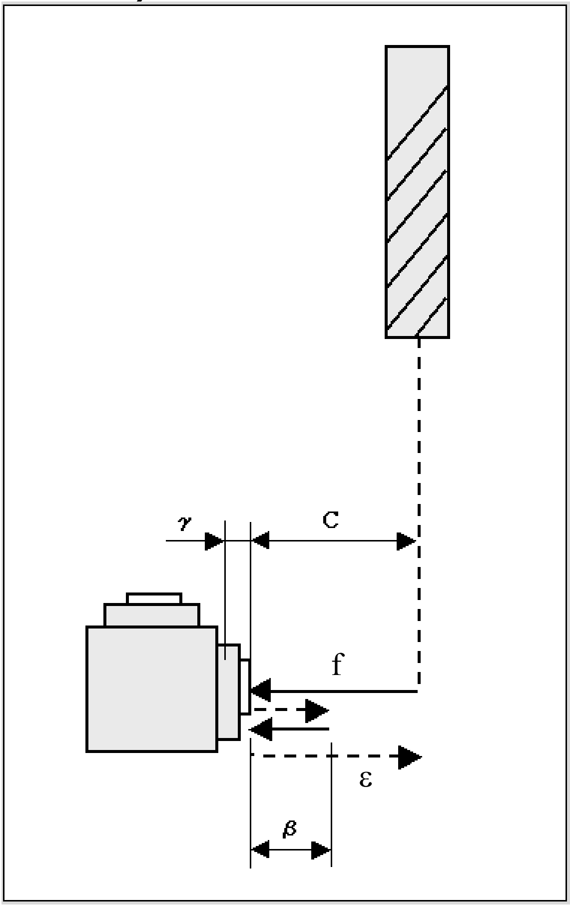
<5> Then, a rapid return movement is made by ε in the +Z-axis direction.

- If [OFSET-] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position - OFS_D).
- If [INPUT+] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position + the value entered in "OFFSET/DIFFERENCE X"). If [INPUT-] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" - the value entered in "OFFSET/DIFFERENCE X").

- If [DIFF+] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position + (OFS_D + the value entered in "OFFSET/DIFFERENCE X")). If [DIFF-] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" - (OFS_D + the value entered in "OFFSET/DIFFERENCE X")).

The descriptions above apply to the input in "SPECIFY OF Y and Z SHIFT" and motion in the Y-axis and Z-axis.

- Measurement of an offset value in the -X-axis direction (measurement of an offset value in the tool radius direction)



The measurement motion described below is made when [AUTO] is selected in all input items of “SPECIFY OF X SHIFT”, “SPECIFY OF Y SHIFT”, and “SPECIFY OF Z SHIFT”.

<1> A rapid movement is made from the current position to the approach point (X coordinate,Y coordinate).
Here, the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position in the specified measurement condition + "CLEARANCE" + OFS_D). The approach point (Y coordinate) represents the Y coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position in the specified measurement condition.

<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate).
Here, the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position in the specified measurement condition + OFS_H).

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

<5> Then, a rapid return movement is made by ε in the +X-axis direction.

If the coordinates of the "sensor position for measurement in the -X direction" of the touch sensor position are shifted from the coordinates of the tool measurement position, specify the shift in "SPECIFY OF X, Y, or Z SHIFT".
For example, the motion described below is made when a soft key other than [AUTO] is selected in "SPECIFY OF Z SHIFT".

- If [OFSET+] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position + OFS_H).
- If [INPUT+] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position + the value entered in "OFFSET/DIFFERENCE Z").
- If [DIFF+] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position + (OFS_H + the value entered in "OFFSET/DIFFERENCE Z")).

The descriptions above apply to the input in "SPECIFY OF X and Y SHIFT" and motion in the X-axis and Y-axis.

- Measurement of an offset value in the +X-axis direction (measurement of an offset value in the tool radius direction)
Same as for measurement in the -X-axis direction

- Measurement of an offset value in the +Y-axis direction (measurement of an offset value in the tool radius direction)
Same as for measurement in the -X-axis direction

- Measurement of an offset value in the -Y-axis direction (measurement of an offset value in the tool radius direction)
Same as for measurement in the -X-axis direction

The symbols used above have the following meanings:
f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

OHS_H : Tool length direction offset value
OFS_D : Tool radius direction offset value

G code format
When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

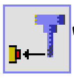
G2010 P_ Q_ C_ F_ H_ D_ V_ R_ L_ Z_ W_ I_ S_ Y_ U_ J_ K_ E_ ;

Measurement result

When G2010 is executed, the result of measurement is output to macro variables for the result of measurement and as a specified tool offset value.

2.3.2 Turning Tool Measurement

When the turning tool is oriented in the Z-axis direction, its figures in the Z-axis and X-axis directions are measured.

Select  "TURNING TOOL MEASUREMENT(TOOL Z-AXIS)" on the [TOOL MESUR] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT METH.

Select a measurement axis direction from the soft keys.

- SPECIFY OF X SHIFT

Select a method of specifying the shift amount from the X coordinate of the position of the touch sensor for tool measurement to the X coordinate of the tool measurement position, from the soft keys.
By default, "AUTO" is selected.
When [AUTO] is selected, the approach position in the X-axis direction at the time of tool measurement is automatically determined by referencing the tool offset value. (For details, see "Measurement motion" described later.)
When [OFSET] is selected, the tool to be measured is approached at the position shifted by the specified tool offset value from the X coordinate of the touch sensor position.
When [INPUT] is selected, the tool is approached at the position shifted by the value input in the next item "OFFSET/DIFFERENCE X" from the X coordinate of the touch sensor position.
When [DIFFER] is selected, the tool is approached at the position shifted by the specified tool offset value added to the value specified by the next item "OFFSET/DIFFERENCE X" from the X coordinate of the touch sensor position.

- OFFSET/DIFFERENCE X

This item is displayed when [INPUT] or [DIFFER] is selected in "SPECIFY OF X SHIFT".
When [INPUT] is selected, enter the shift amount from the X coordinate of the touch sensor position for tool measurement to the X coordinate of the tool measurement position.
When [DIFFER] is selected, enter a value so that the tool offset value added to the value specified by this item is the shift amount from the X coordinate of the touch sensor position for tool measurement to the X coordinate of the tool measurement position.

- SPECIFY OF Y SHIFT, SPECIFY OF Z SHIFT

Same as "SPECIFY OF X SHIFT"

- OFFSET/DIFFERENCE Y, OFFSET/DIFFERENCE Z

Same as "OFFSET/DIFFERENCE X"

The descriptions of the other items are the same as for the “Milling Tool Measurement”.

[T-TOOL] tab

This screen is the input screen (for turning) used for automatic tool offset setting.
This screen enables specification for setting a measured value as a tool offset value on the turning side.

OK RANGE AND FEEDBACK RANGE COMPARISON TARGET

If a value other than [INPUT] is entered in "SPECIFY OF X, Y, or Z SHIFT", a decision is made by comparing the offset value currently set as the tool offset value with the result of measurement.

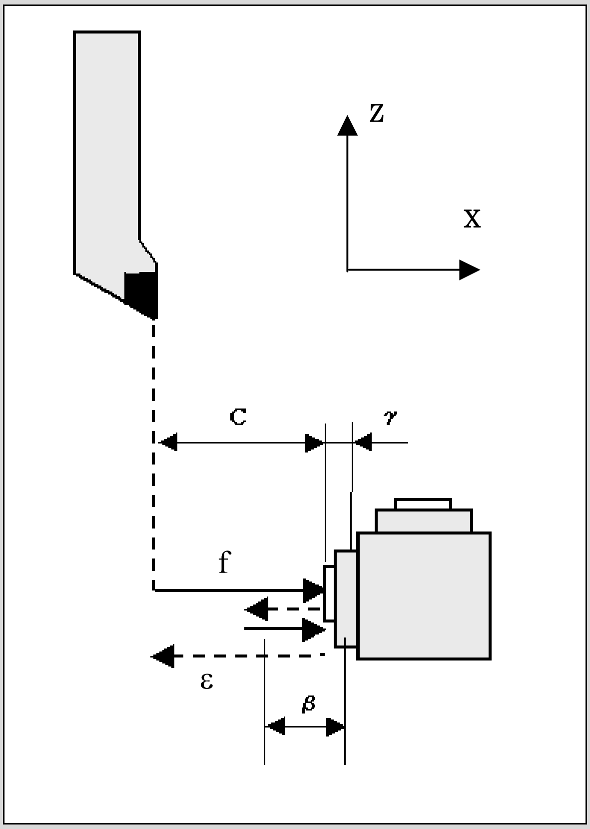
If [INPUT] is entered in "SPECIFY OF X, Y, or Z SHIFT", a decision is made by comparing the value entered in "OFFSET/DIFFERENCE X, Y or Z" with the result of measurement.

To the other items, the descriptions in "Milling Tool Measurement" are applied.

Measurement motion

Measurement motion is described below.

- Measurement of an offset value in the +X-axis direction



The measurement motion described below is made when [AUTO] is selected in all input items of “SPECIFY OF X SHIFT”, “SPECIFY OF Y SHIFT”, and “SPECIFY OF Z SHIFT”.

<1> A rapid movement is made from the current position to the approach point (X coordinate,Y coordinate).
Here, the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the +X direction" of the touch sensor position in the specified measurement condition - "CLEARANCE" + OFS_X). The approach point (Y coordinate) represents the Y coordinate of the "sensor position for measurement in the +X direction" of the touch sensor position in the specified measurement condition.

<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate).
Here, the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the +X direction" of the touch sensor position in the specified measurement condition + OFS_Z).

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

<5> Then, a rapid return movement is made by ε in the -X-axis direction.

If the coordinates of the "sensor position for measurement in the +X direction" of the touch sensor position are shifted from the coordinates of the tool measurement position, specify the shift in "SPECIFY OF X, Y, or Z SHIFT".
For example, the motion described below is made when a soft key other than [AUTO] is selected in "SPECIFY OF Z SHIFT".

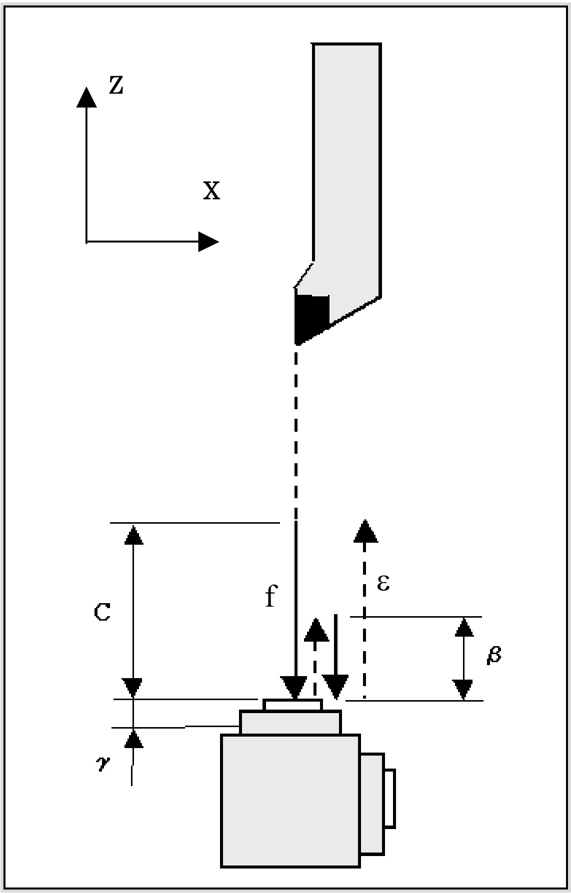
- If [OFFSET] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the +X direction" of the touch sensor position + OFS_Z).
- If [INPUT] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the + X direction" of the touch sensor position + the value entered in "OFFSET/DIFFERENCE Z").
- If [DIFFER] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the +X direction" of the touch sensor position + (OFS_Z + the value entered in "OFFSET/DIFFERENCE Z")).

The descriptions above apply to the input in "SPECIFY OF X and Y SHIFT" and motion in the X-axis and Y-axis.

- Measurement of an offset value in the -X-axis direction

Same as for measurement of an offset value in the +X-axis direction

- Measurement of an offset value in the -Z-axis direction



The measurement motion described below is made when [AUTO] is selected in all input items of “SPECIFY OF X SHIFT”, “SPECIFY OF Y SHIFT”, and “SPECIFY OF Z SHIFT”.

<1> A rapid movement is made from the current position to the approach point (X coordinate,Y coordinate).
Here, the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" + OFS_X). The approach point (Y coordinate) represents the Y coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position in the specified measurement condition.

<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate).
Here, the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position in the specified measurement condition + "CLEARANCE" + OFS_Z).

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement).

<5> Then, a rapid return movement is made by ε in the +Z-axis direction.

If the coordinates of the "sensor position for measurement in the -Z direction" of the touch sensor position are shifted from the coordinates of the tool measurement position, specify the shift in "SPECIFY OF X, Y, or Z SHIFT".
For example, the motion described below is made when a soft key other than [AUTO] is selected in "SPECIFY OF X SHIFT".

- If [OFFSET] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position + OFS_X).
- If [INPUT] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position + the value entered in "OFFSET/DIFFERENCE X").
- If [DIFFER] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position + (OFS_X + the value entered in "OFFSET/DIFFERENCE X")).

The descriptions above apply to the input in "SPECIFY OF Y and Z SHIFT" and motion in the Y-axis and Z-axis.

The symbols used above have the following meanings:
f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

OHS_X : X-axis direction offset value
OFS_Z : Z-axis direction offset value

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2011 P_ Q_ C_ F_ H_ D_ V_ R_ L_ Z_ W_ I_ S_ Y_ ;

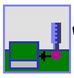
Measurement result

When G2011 is executed, the result of measurement is output to macro variables for the result of measurement and as a specified tool offset value.

2.4 WORK SET (PROBE Z-AXIS DIRECTION)

2.4.1 End Face (X-axis Direction) Measurement

The position of an end face in the X-axis direction is measured.

Select  "X-AXIS DIRECTION WORK SETUP(PROBE Z-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT DIREC.

Select an axis movement direction for measurement from the soft keys.

- MEASUREMENT COND.

Enter a measurement condition group number to be referenced at measurement time, by specifying a numeric value.

- MEASURE POINT X, Y, Z

Enter the correct workpiece coordinates of the end face by specifying numeric values.

- APROCH DISTANCE

Enter the move distance from the approach point to a measurement position in the Z-axis direction by specifying a numeric value.

- MOVING MEAS. SPEED

Enter a feedrate for measurement by specifying a numeric value.

[T-WORK] tab

This screen is the input screen (for turning) used for automatic workpiece origin offset setting.
This screen enables specification for setting a measured value as a workpiece origin offset value on the turning side.

> **NOTE**
> With the CNC for a machining center, the [T-WORK] tab is not displayed.

- SETTING DEST. (T)

Enter a workpiece origin offset value number with which the result of measurement is to be set.
Otherwise, the result of measurement is not set as a workpiece origin offset value.
When the setting destination is a workpiece coordinate system from G54 to G59, directly enter a numeric value from 54 to 59.
When the setting destination is an additional workpiece coordinate system set, enter a numeric value as follows:
(Example of input)
For G54.1P1 → Enter "1001".
For G54.1P48 → Enter "1048".

> **NOTE**
> "Additional 48 workpiece coordinate system sets" are optional. On the lathe side of an NC for complex machining, the optional function "additional 48 workpiece coordinate system sets" are not available.

- WORK COORD. VALUE

Enter the coordinates of the position of a measurement point in the workpiece coordinate system by specifying numeric values.

- OK RANGE (±)

Enter an allowable range of errors obtained from measurement, by specifying a numeric value.
If the difference between the obtained result of measurement and the correct coordinate (input value "MEASURE POINT") is within this allowable range, the absence of errors is assumed, and no setting is performed as a workpiece origin offset value.

- FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.

Processing when the OK range and the feedback range are 0

When the OK range and the feedback range are set to 0, the processing below is performed.

<1> When both the OK range and the feedback are set to 0
  The result of measurement is not set in the setting destination. Moreover, no alarm is issued as a result of measurement. (The result of measurement is just recorded in the measurement result list.)

<2> When the OK range is set to 0, and the feedback range is set to a nonzero value
  If an error obtained from measurement is within the feedback range, the result of measurement is set in the setting destination.
  If an error obtained from measurement exceeds the feedback range, an alarm is issued.

<3> When the OK range is set to a nonzero value, and the feedback range is set to 0
  An alarm is issued.

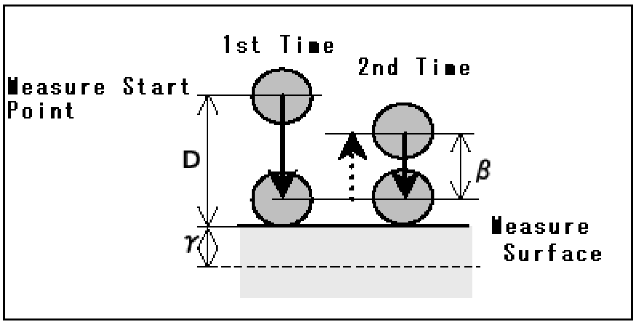
[M-WORK] tab

This screen is the input screen (for milling) used for automatic workpiece origin offset setting.
This screen enables specification for setting a measured value as a workpiece origin offset value on the milling side.
The contents are the same as for the [T-WORK] tab described earlier.

> **NOTE**
> 1 With the CNC for a lathe, the [M-WORK] tab is not displayed.
> 2 "Additional 48 workpiece coordinate system sets" and "additional 300 workpiece coordinate system sets" are optional.
> On an NC for complex machining, the optional function "additional 300 workpiece coordinate system sets" are not available.

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the approach point (X coordinate,Y coordinate).
Here, the approach point (X coordinate) represents ("MEASURE POINT X" - α) when the measurement direction is "+X", or the approach point (X coordinate) represents ("MEASURE POINT X" + α) when the measurement direction is "-X". The approach point (Y coordinate) is the same as "MEASURE POINT Y".
<2> In the Z-axis direction, a rapid movement is made to the point ("MEASURE POINT Z" + "APROCH DISTANCE").
<3> In the Z-axis direction, a movement is made to "MEASURE POINT Z" at feedrate fb.
<4> In the range from the approach point to (α + γ - stylus ball radius r), a measurement is made at feedrate f. (First measurement)
<5> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)
<6> Then, a return movement is made by "APROCH DISTANCE" in the Z-axis direction.

The symbols used above have the following meanings:

f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."
α: Value of “APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

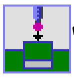
```
G2020 Q_ P_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2020 is executed, the result of measurement is output to macro variables for the result of measurement and as the X coordinate of a specified workpiece origin offset value.

2.4.2 End Face (Y-axis Direction) Measurement

The position of an end face in the Y-axis direction is measured.

Select  "Y-AXIS DIRECTION WORK SETUP(PROBE Z-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT DIREC.

Select an axis movement direction for measurement from the soft keys.

The descriptions of the other items are the same as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)".

[T-WORK] and [M-WORK] tabs

The input screen for automatic workpiece offset setting is the same as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)," except that the screen title is changed to "Y-AXIS DIRECTION WORK SETUP(PROBE Z-AXIS)."

Measurement motion

<1> A rapid movement is made from the current position to the approach point (X coordinate,Y coordinate).
Here, the approach point (X coordinate) is the same as "MEASURE POINT X".
The approach point (Y coordinate) represents ("MEASURE POINT Y" – APROCH DISTANCE) when the measurement direction is "+Y", or the approach point (Y coordinate) represents ("MEASURE POINT Y" + APROCH DISTANCE) when the measurement direction is "-Y".

Other motions are the same as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)".

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

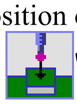
```
G2021 Q_ P_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2021 is executed, the result of measurement is output to macro variables for the result of measurement and as the Y coordinate of a specified workpiece origin offset value.

2.4.3 End Face (Z-axis Direction) Measurement

The position of an end face in the Z-axis direction is measured.

Select  "Z-AXIS DIRECTION WORK SETUP(PROBE Z-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT DIREC.

Select an axis movement direction for measurement from the soft keys.

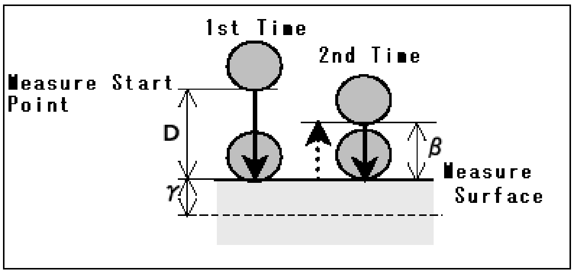
The descriptions of the other items are the same as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)".

[T-WORK] and [M-WORK] tabs

The descriptions of the input items are the same as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)", except that the screen title changes to "Z AXIS DIRECTION WORK SETUP (PROBE Z-AXIS).

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by "MEASURE POINT X" and "MEASURE POINT Y".

<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate).
Here, the approach point (Z coordinate) represents ("MEASURE POINT Z" - "APROCH DISTANCE") when the measurement direction is "+Z", or the approach point (Z coordinate) represents ("MEASURE POINT Z" + "APROCH DISTANCE") when the measurement direction is "-Z".

<3> In the range from the approach point to ("APROCH DISTANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made to the position (first measurement point + β), and a measurement is made in the range from that position to (first measurement point - γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

The symbols used above have the following meanings:

f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND.

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

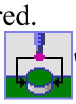
G2022 Q_ P_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;

Measurement result

When G2022 is executed, the result of measurement is output to macro variables for the result of measurement and as the Z coordinate of a specified workpiece origin offset value.

2.4.4 Outside Diameter Measurement

When the probe is oriented in the Z-axis direction, the center position of the outside diameter of a circle is measured.

Select  "OUTSIDE DIAMETER WORK SETUP(PROBE Z-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT COND.

Enter a measurement condition group number to be referenced at measurement time, by specifying a numeric value.

- OUTSIDE DIAMETER

Enter the correct outside diameter of a circle by specifying a numeric value.

- CENTER POINT X, Y

Enter the correct X and Y coordinates of the center of a circle by specifying numeric values.

- HEIGHT OF MEAS. PT.

Enter the height of a measurement position in the Z-axis direction by specifying a numeric value.

- APROCH DISTANCE

Enter the move distance from the approach point to a measurement position in the Z-axis direction by specifying a numeric value.

- MOVING MEAS. SPEED

Enter a feedrate for measurement by specifying a numeric value.

- MEASUREMENT POINT

Enter the number of measurement points by specifying a numeric value (1 to 4).

- SPINDLE ORIENTATION

Select whether to perform spindle orientation for each measurement point, from the soft keys.

> **NOTE**
> The "spindle orientation function" is an optional function.

[T-WORK] tab

This screen is the input screen (for turning) used for automatic workpiece offset setting.
This screen enables specification for setting a measured value as a workpiece origin offset value on the turning side.

> **NOTE**
> With the CNC for a machining center, the [T-WORK] tab is not displayed.

- WORK COORD. VALUE X

Enter the X coordinate of the position of a measurement point in the specified workpiece coordinate system by specifying a numeric value.

- WORK COORD. VALUE Y

Enter the Y coordinate of the position of a measurement point in the specified workpiece coordinate system by specifying a numeric value.

- OK RANGE (±)

Enter an allowable range of errors obtained from measurement, by specifying a numeric value.
If the difference between the center coordinate obtained from measurement and the correct value (input value "CENTER POINT X" or "CENTER POINT Y") is within this allowable range, the absence of errors is assumed, and no setting is performed as a workpiece origin offset value.

- FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.

> **NOTE**
> If one of the center X coordinate and center Y coordinate exceeds the feedback range, an alarm is issued. If the error of the other coordinate is within the feedback range in this case, the data is not set as a workpiece origin offset value.
> If one of the center X coordinate and center Y coordinate is within the feedback range, the data is set in the workpiece coordinate system. If the error of the other coordinate is within the OK range, the data is not set as a workpiece origin offset value.
> If one of WORK COORD. VALUE X and WORK COORD. VALUE Y is not entered, the data of the axis is not checked for an error, and is not set as a workpiece origin offset value.

The descriptions of the other items are the same as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)".

Processing when the OK range and the feedback range are 0

The same processing as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)" is performed.

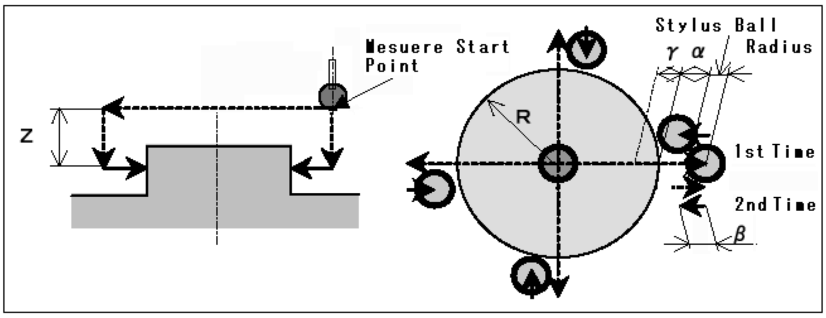
[M-WORK] tab

This screen is the input screen (for milling) used for automatic workpiece offset setting.
This screen enables specification for setting a measured value as a workpiece origin offset value on the milling side.
The contents are the same as for the [T-WORK] tab described earlier.

> **NOTE**
> With the CNC for a lathe, the [M-WORK] tab is not displayed.

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT X" + ("OUTSIDE DIAMETER"/2 + α +r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<2> In the Z-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<3> In the -Z-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<4> If "ON" is selected for "SPINDLE ORIENTATION", spindle orientation is performed here.

<5> In the range of ($\alpha + \gamma$), a measurement is made at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to ($\beta + \gamma$). (Second measurement)
<7> Next, a rapid return movement is made by ε, and a rapid return movement is made in the Z-axis direction to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<8> A rapid movement is made to "CENTER POINT X", then a movement is made in the -X-axis direction by the distance ("OUTSIDE DIAMETER"/2 + α + r) at feedrate fa.
<9> A similar measurement is made in the -X-axis direction and ±Y-axis directions.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of “APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

Motion depending on the number of measurement points

When "MEASUREMENT POINT" is set to 1, a measurement is made in the +X-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +X-axis and -X-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +X-axis, -X-axis, and +Y-axis directions only.

When bit 0 (CRY) of parameter No. 12380 is set to 1, however, a measurement is made as follows:
When "MEASUREMENT POINT" is set to 1, a measurement is made in the +Y-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +Y-axis and –Y-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +Y-axis, -Y-axis, and +X-axis directions only.

Motion when spindle orientation is enabled

When ON is selected for "SPINDLE ORIENTATION", spindle orientation is performed for each measurement point.
Measurement in the +X-axis direction → Spindle orientation to the 0° position
Measurement in the -X-axis direction → Spindle orientation to the 180° position
Measurement in the +Y-axis direction → Spindle orientation to the 270° position
Measurement in the -Y-axis direction → Spindle orientation to the 90° position

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

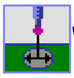
G2023 Q_ D_ H_ V_ L_ R_ F_ P_ M_ W_ I_ J_ S_ Y_ U_ A_ B_ K_ E_ ;

Measurement result

When G2023 is executed, the center of the circle is found from the measured value, and is output to macro variables for the result of measurement and as a specified workpiece origin offset value.

2.4.5 Inside Diameter Measurement

When the probe is oriented in the Z-axis direction, the center position of the inside diameter of a circle is measured.

Select  "INSIDE DIAMETER WORK SETUP(PROBE Z-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

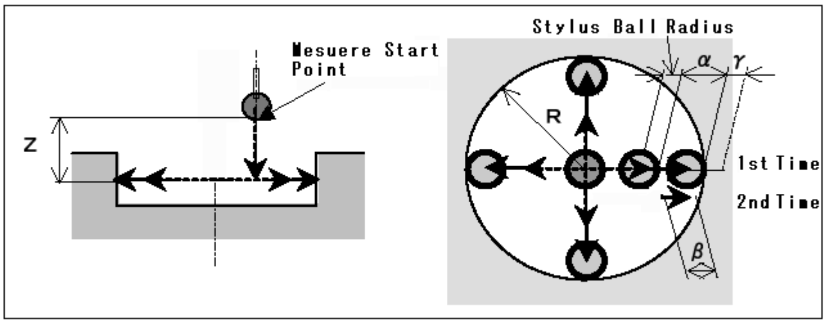
The descriptions of the input items are the same as for "Outside Diameter Measurement".

[T-WORK] and [M-WORK] tabs

The input screens for automatic workpiece offset setting are the same as for "OUTSIDE DIAMETER MEASUREMENT."

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT X" + ("INSIDE DIAMETER"/2 - α -r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<2> In the Z-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<3> Next, a movement is made in the -Z-axis direction to the point specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<4> If "ON" is selected for "SPINDLE ORIENTATION", spindle orientation is performed here.
<5> In the range of (α + γ) from that point, a measurement is made at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<7> After a rapid return movement is made by ε, a rapid movement is made to the X coordinate specified by "CENTER POINT X", then a movement is made in the -X-axis direction by the distance ("INSIDE DIAMETER"/2 - α - r) at feedrate fa.
<8> A similar measurement is made in the -X-axis direction and ±Y-axis directions.
<9> A return movement is made by "APROCH DISTANCE" in the Z-axis direction.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of “APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

Motion depending on the number of measurement points

Same as for "Outside Diameter Measurement"

Motion when spindle orientation is enabled

Same as for "Outside Diameter Measurement"

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

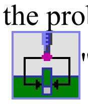
G2024 Q_ D_ H_ V_ L_ R_ F_ P_ M_ W_ I_ J_ S_ Y_ U_ A_ B_ K_ E_ ;

Measurement result

When G2024 is executed, the center of the circle is found from the measured value, and is output to macro variables for the result of measurement and as a specified workpiece origin offset value.

2.4.6 Outside Width Measurement

When the probe is oriented in the Z-axis direction, the center position of a projection width is measured.

Select  "OUTSIDE WIDTH WORK SETUP(PROBE Z-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT DIREC.

Select a measurement axis direction from the soft keys.

- PROJECTION WIDTH

Enter the correct size of a projection width by specifying a numeric value.

- CENTER POINT X, Y

Enter the correct center coordinates of a groove by specifying numeric values.
For the direction other than the measurement direction, enter the coordinate of a measurement point.

The descriptions of the other input items are the same as for "OUTSIDE DIAMETER WORK SETUP (PROBE Z-AXIS)".

[T-WORK] tab

This screen is the input screen (for turning) used for automatic workpiece origin offset setting.
This screen enables specification for setting a measured value as a workpiece origin offset value on the turning side.

> **NOTE**
> With the CNC for a machining center, the [T-WORK] tab is not displayed.

- OK RANGE (±)

Enter an allowable range of errors obtained from measurement, by specifying a numeric value.
If the difference between the center coordinate obtained from measurement and the correct value (input value "CENTER POINT X" or "CENTER POINT Y") is within this allowable range, the absence of errors is assumed, and no setting is performed as a workpiece origin offset value.

- FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.
The descriptions of the other items are the same as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)".

Processing when the OK range and the feedback range are 0

The same processing as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)" is performed.

[M-WORK] tab

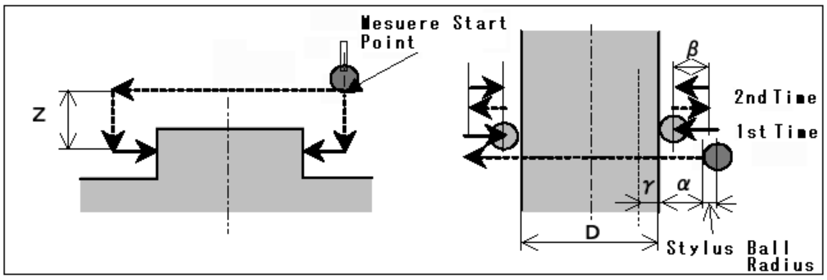
This screen is the input screen (for milling) used for automatic workpiece origin offset setting.
This screen enables specification for setting a measured value as a workpiece origin offset value on the milling side.

> **NOTE**
> With the CNC for a lathe, the [M-WORK] tab is not displayed.

The descriptions of the input items are the same as for the turning side.

Measurement motion

Measurement motion is described below.



<1> For measurement in the X-axis direction, a rapid movement is made from the current position to the point specified by ("CENTER POINT X" + ("PROJECTION WIDTH"/2 + α + r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction. Similarly, for measurement in the Y-axis direction, a rapid movement is made from the current position to the point specified by "CENTER POINT X" in the X-axis direction and by ("CENTER POINT Y" + ("PROJECTION WIDTH"/2 + α + r)) in the Y-axis direction.

<2> In the Z-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<3> A movement is made in the -Z-axis direction to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb, then a measurement is made in the range from that position to ($\alpha + \gamma$) at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to ($\beta + \gamma$). (Second measurement)

<5> Then, a rapid return movement is made by ε, and a rapid return movement is made in the Z-axis direction to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<6> A rapid movement is then made to the center coordinates. Next, a movement is made to the approach point on the minus (-) side at feedrate fa. Then, a similar measurement is also made in the -X-axis (-Y-axis) direction.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of “APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

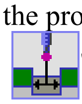
```
G2025 P_ Q_ D_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2025 is executed, the center of the projection width is found from the measured value, and is output to macro variables for the result of measurement and as a specified workpiece origin offset value.

2.4.7 Inside Width Measurement

When the probe is oriented in the Z-axis direction, the center position of a groove width is measured.

Select  "INSIDE WIDTH WORK SETUP(PROBE Z-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

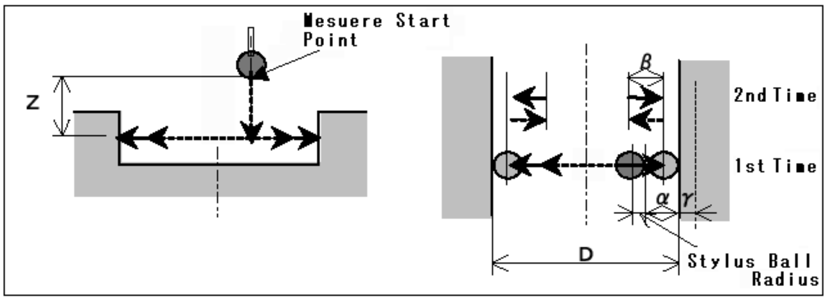
The descriptions of the input items are the same as for "OUTSIDE WIDTH WORK SETUP (PROBE Z-AXIS)".

[T-WORK] and [M-WORK] tabs

The input screens for automatic workpiece offset setting are the same as for "OUTSIDE WIDTH WORK SETUP (PROBE Z-AXIS)."

Measurement motion

Measurement motion is described below.



<1> For measurement in the X-axis direction, a rapid movement is made from the current position to the point specified by ("CENTER POINT X" + ("GROOVE WIDTH"/2 - α - r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction. Similarly, for measurement in the Y-axis direction, a rapid movement is made from the current position to the point specified by "CENTER POINT X" in the X-axis direction and by ("CENTER POINT Y" + ("GROOVE WIDTH"/2 - α - r)) in the Y-axis direction.

<2> In the Z-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<3> In the -Z-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.

<4> Then, a measurement is made at feedrate f in the +X-axis (+Y-axis) direction in the range (α + γ). (First measurement)

<5> Then, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)

<6> A rapid movement is then made to the center coordinates. Next, a movement is made to the approach point on the minus (-) side at feedrate fa. Then, a similar measurement is also made in the -X-axis (-Y-axis) direction.

<7> A return movement is made by "APROCH DISTANCE" in the Z-axis direction.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of “APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

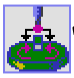
G2026 P_ Q_ D_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;

Measurement result

When G2026 is executed, the center of the groove width is found from the measured value, and is output to macro variables for the result of measurement and as a specified workpiece origin offset value.

2.4.8 C-axis Outside Width Measurement

When the probe is oriented in the Z-axis direction, the center angle of a projection width in the C-axis direction is measured.

Select  "C-AXIS OUTSIDE WIDTH WORK SETUP(PROBE Z-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

> **NOTE**
> When absolute coordinates is not rounded in 0 to 360°(prameter No.1006#1=1,#0=1),and measurement range angle is greater than 180°, Outside width measurement and Inside width measurement is not available.

[MOTION] tab

- MEASURE POINT X, Y

Enter the X and Y coordinates of a measurement position by specifying numeric values.

- CENTER ANGLE

Enter the correct center angle C of a projection width by specifying a numeric value (in the input unit for angle).

- ANGLE RANGE OF MEAS

Specify a measurement range angle relative to the center angle.
Set a value greater than the angle from the center angle to the end of the projection width.
The descriptions of the other input items are the same as for "OUTSIDE DIAMETER WORK SETUP (PROBE Z-AXIS)".

[T-WORK] tab

This screen is the input screen (for turning) used for automatic workpiece origin offset setting.
This screen enables specification for setting a measured value as a workpiece origin offset value on the turning side.

> **NOTE**
> With the CNC for a machining center, the [T-WORK] tab is not displayed.

- OK RANGE (±)

Enter an allowable range of errors obtained from measurement, by specifying a numeric value.
If the difference between the center angle obtained from measurement and the correct value (input value "CENTER ANGLE") is within this allowable range, the absence of errors is assumed, and no setting is performed as a workpiece origin offset value.

- FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.
Enter a numeric value.
The descriptions of the other input items are the same as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)"

Processing when the OK range and the feedback range are 0

The same processing as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)" is performed.

[M-WORK] tab

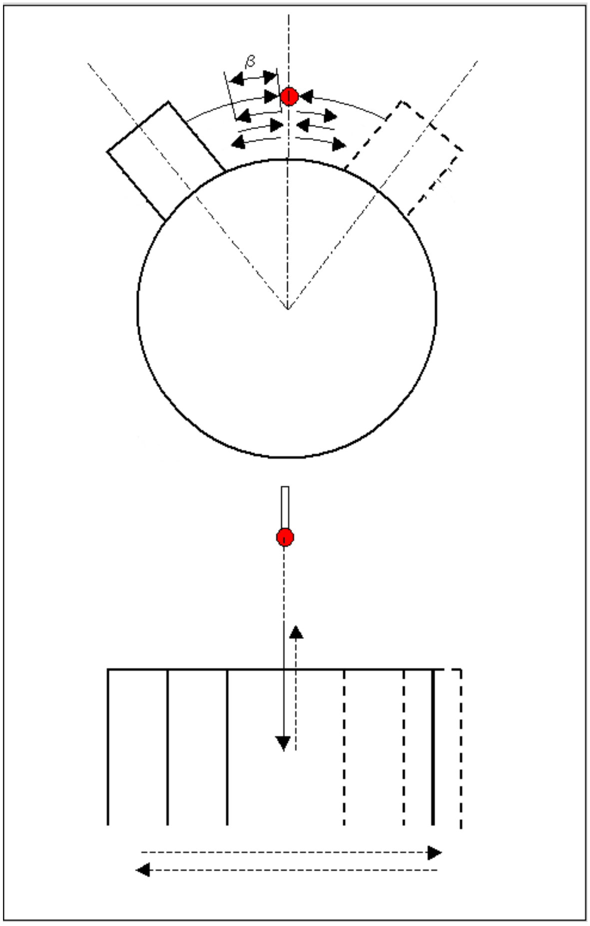
This screen is the input screen (for milling) used for automatic workpiece origin offset setting.
This screen enables specification for setting a measured value as a workpiece origin offset value on the milling side.

> **NOTE**
> With the CNC for a lathe, the [M-WORK] tab is not displayed.

The contents are the same as for the [T-WORK] tab.

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by "MEASURE POINT X" and "MEASURE POINT Y".

<2> Next, a rapid movement is made in the C-axis direction to the point ("CENTER ANGLE" - "ANGLE RANGE OF MEAS").
<3> In the Z-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<4> In the -Z-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<5> In the +C-axis direction, a measurement is made in the range of "ANGLE RANGE OF MEAS" at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<7> Then, a rapid return movement is made by ε, and a rapid return movement is made in the Z-axis direction to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<8> Then, a rapid movement is made in the C-axis direction to the point ("CENTER ANGLE" + "ANGLE RANGE OF MEAS").
<9> A similar measurement is made in the -C-axis direction.

The symbols used above have the following meanings:

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."
f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
α: Value of "APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

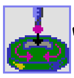
```
G2031 Q_ H_ V_ C_ A_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2031 is executed, the center angle of the projection width is found from the measured value, and is output to macro variables for the result of measurement and as a specified workpiece origin offset value.

2.4.9 C-axis Inside Width Measurement

When the probe is oriented in the Z-axis direction, the center angle of a groove in the C-axis direction is measured.

Select  "C-AXIS INSIDE WIDTH WORK SETUP(PROBE Z-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

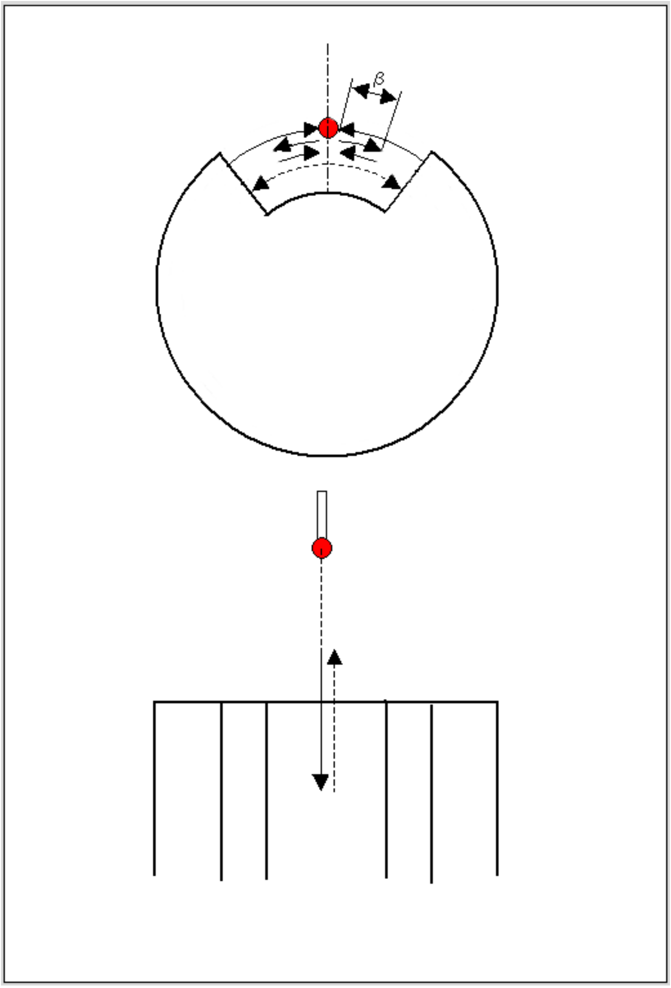
The descriptions of the input items are the same as for "C-AXIS OUTSIDE WIDTH WORK SETUP (PROBE Z-AXIS)".

[T-WORK] and [M-WORK] tabs

The input screens for automatic workpiece offset setting are the same as for "C-AXIS OUTSIDE WIDTH WORK SETUP."

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by "MEASURE POINT X" and "MEASURE POINT Y".
<2> Next, a rapid movement is made in the C-axis direction to the point specified by "CENTER ANGLE".
<3> In the Z-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<4> In the -Z-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<5> In the +C-axis direction, a measurement is made in the range of "ANGLE RANGE OF MEAS" at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<7> Then, a rapid movement is made in the C-axis direction to the measurement start point.
<8> A similar measurement is made in the -C-axis direction.
<9> A return movement is made by "APROCH DISTANCE" in the Z-axis direction.

The symbols used above have the following meanings:

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of “APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2032 Q_ H_ V_ C_ A_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;

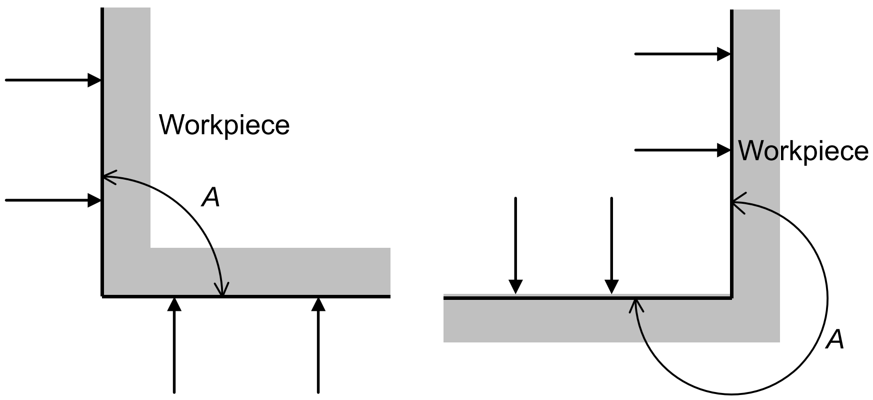
Measurement result

When G2032 is executed, the center angle of the groove width is found from the measured value, and is output to macro variables for the result of measurement and as a specified workpiece origin offset value.

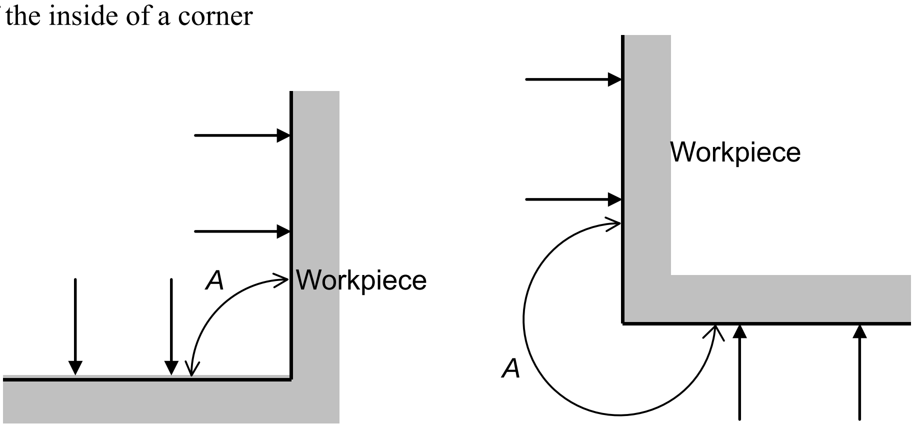
2.4.10 Measurement of the Outside of a Corner/the Inside of a Corner

On the X-Y plane, the outside of a corner/the inside of a corner is measured. The result of measurement is output to the specified workpiece origin offset number and macro variable.

- Angle of the outside of a corner

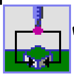


- Angle of the inside of a corner



> **NOTE**
> 1 This function is enabled when bit 3 (CNR) of parameter No. 27222 is set to 1.
> 2 This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

Data input screen (corner outside measurement in the probe Z-axis direction)

Select  "MEASUREMENT OF CORNER OUTSIDE (PROBE Z-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen.

Measurement execution page 1

MEAS.EXEC1		
Input item		**Meaning**
Q	MEASUREMENT COND.	Measurement condition (centering measurement condition group number)
H	1ST MEAS.STRT PT.X	X coordinate of the measurement position of the first point (start position)
V	1ST MEAS.STRT PT.Y	Y coordinate of the measurement position of the first point (start position)
X	2ND MEAS.STRT PT.X	X coordinate of the measurement position of the second point (start position)
Z	2ND MEAS.STRT PT.Y	Y coordinate of the measurement position of the second point (start position)
A	3RD MEAS.STRT PT.X	X coordinate of the measurement position of the third point (start position)
B	3RD MEAS.STRT PT.Y	Y coordinate of the measurement position of the third point (start position)
C	4TH MEAS.STRT PT.X	X coordinate of the measurement position of the fourth point (start position)
D	4TH MEAS.STRT PT.Y	Y coordinate of the measurement position of the fourth point (start position)

Measurement execution page 2

MEAS.EXEC2		
Input item		**Meaning**
M	1ST MEAS.DIRECTION	Measurement direction for the first point and second point
P	3RD MEAS.DIRECTION	Measurement direction for the third point and fourth point
U	CORNER COORD.VAL.X	Corner coordinate X (target value)
E	CORNER COORD.VAL.Y	Corner coordinate Y (target value)
L	HEIGHT OF MEAS.PT.	Height of a measurement position in the Z-axis direction
R	APROCH DISTANCE	Move distance from the approach point to a measurement position in the Z-axis direction
F	MOVING MEAS.SPEED	Feedrate at measurement time

SET-WORK		
Input item		**Meaning**
W	SETTING DEST.	Workpiece origin offset number for storing the result of measurement
I	WORK COORD.VALUE X	X coordinate of a measurement position in the specified workpiece coordinate system
J	WORK COORD.VALUE Y	Y coordinate of a measurement position in the specified workpiece coordinate system
S	OK RANGE (±)	Specify an allowable range of measurement errors for ignoring the result of measurement. If the difference between the outside/inside position of a corner obtained from measurement and the correct corner position is within this range, the difference is treated as an allowable error and the result of measurement is not set in a macro variable.
Y	FEED BACK RANGE (±)	If an error obtained from the result of measurement is in the range from the OK range to this feedback range, the result of measurement is set in the setting destination. If an obtained error exceeds the feedback range, an alarm is issued.

SET-WORK		
Input item		Meaning
T	SETTING MACRO VAL.	Macro variable number for storing the result of corner angle measurement. By default, the value set in parameter No. 27246 is displayed. If 0 is set in this parameter, the specification of no value is assumed. If a variable number is set, a measured corner angle is stored in the macro variable.

G code format (corner outside measurement in the probe Z-axis direction)

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2027 Q_ H_ V_ X_ Z_ A_ B_ C_ D_ M_ P_ U_ E_ L_ R_ F_ W_ I_ J_ S_ Y_ T_ ;

Measurement motion (corner outside measurement in the probe Z-axis direction)

After a rapid movement is made from the current position to the first measurement start position and the measurement height in the Z-axis direction is reached, a measurement is made in the first measurement direction. A measurement is sequentially made for the second point, third point, and fourth point.

Measurement result (corner outside measurement in the probe Z-axis direction)

When G2027 is executed, corner coordinates are processed according to the result of measurement if the specification of the input items on the "SET-WORK" screen is not omitted. A corner angle is always output to a macro variable if the setting destination macro variable number is other than 0.

- When the result of measurement is "OK"
  The error is assumed to be in the allowable range, and corner coordinates are not set.
- When the result of measurement is "FB"
  Corner coordinates calculated from the result of measurement are set in the specified offset number in the specified workpiece coordinate system.
- When the result of measurement is "NG"
  Corner coordinates are not set.

Other measurements

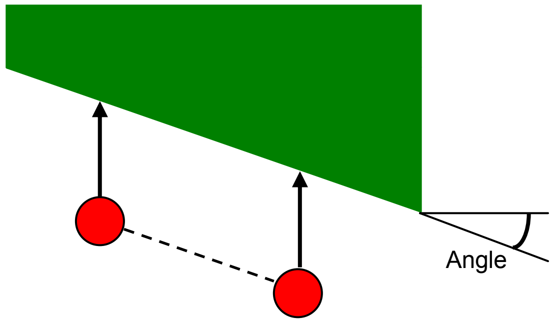
The other measurements are the same as the measurement of the outside of a corner (probe Z-axis direction).

The G code format is as follows:

G code	Measurement cycle
G2028	Measurement of the inside of a corner (probe Z-axis direction)
G2127	Measurement of the outside of a corner (probe X-axis direction)
G2128	Measurement of the inside of a corner (probe X-axis direction)

2.4.11 Measurement of the Angle of a Slanted Workpiece

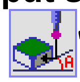
The angle of a slanted workpiece can be measured. The result of measurement is output to the specified macro variable. Moreover, by using an angle obtained from measurement as an angular displacement about the Z-axis, the coordinate system rotation command (G68) can be automatically executed.



(Measurement of the angle of a slanted workpiece)

> **NOTE**
> 1 This function is enabled when bit 2 (AWM) of parameter No. 27222 is set to 1.
> 2 This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

Data input screen

Select  "ANGLED WORK MEASUREMENT (PROBE Z-AXIS)" on the [SET ERROR] tab of the measurement cycle menu screen. The following input items appear:

MEASURE		
Input item		Meaning
P	MEASURE DIRECTION	Measurement direction. Select a direction from the [+X], [-X], [+Y], and [-Y] soft keys.
Q	MEASUREMENT COND.	Measurement condition (centering measurement condition group number)
H	1ST MEAS.STRT PT.X	X coordinate of the measurement position of the first point (start position)
V	1ST MEAS.STRT PT.Y	Y coordinate of the measurement position of the first point (start position)
A	ANG. DISPLACEMENT	Workpiece slant (angle with the +X-axis representing 0°)
C	2ND MEAS.STRT PT.X	X coordinate of the measurement position of the second point (start position)
D	2ND MEAS.STRT PT.Y	Y coordinate of the measurement position of the second point (start position)
L	HEIGHT OF MEAS.PT.	Height of a measurement position in the Z-axis direction
R	APROCH DISTANCE	Move distance from the approach point to a measurement position in the Z-axis direction
F	MOVING MEAS.SPEED	Feedrate at measurement time

VALIABLE T		
Input item		Meaning
W	SETTING MACRO VAL.	Macro variable number for storing the result of measurement. By default, the value set in parameter No. 27246 is displayed.
X	CENTER X OF ROT.	Set the rotation center X coordinate for coordinate system rotation.
Z	CENTER Y OF ROT.	Set the rotation center Y coordinate for coordinate system rotation.
S	OK RANGE (±)	Specify an allowable range of measurement errors for ignoring the result of measurement. If the difference between the angle obtained from measurement and the correct angular displacement is within this range, the difference is treated as an allowable error and the result of measurement is not set in a macro variable.

VALIABLE T		
Input item		**Meaning**
Y	FEED BACK RANGE (±)	If an error obtained from the result of measurement is in the range from the OK range to this feedback range, the result of measurement is set in the setting destination. If an obtained error exceeds the feedback range, an alarm is issued.

NOTE
With the CNC for a machining center, the "VALIABLE T" tab is not displayed.

VALIABLE M		
Input item		**Meaning**
U	SETTING MACRO VAL.	Macro variable number for storing the result of measurement. By default, the value set in parameter No. 27246 is displayed.
I	CENTER X OF ROT.	Set the rotation center X coordinate for coordinate system rotation.
J	CENTER Y OF ROT.	Set the rotation center Y coordinate for coordinate system rotation.
K	OK RANGE (±)	Specify an allowable range of measurement errors for ignoring the result of measurement. If the difference between the angle obtained from measurement and the correct angular displacement is within this range, the difference is treated as an allowable error and the result of measurement is not set in a macro variable.
E	FEED BACK RANGE (±)	If an error obtained from the result of measurement is in the range from the OK range to this feedback range, the result of measurement is set in the setting destination. If an obtained error exceeds the feedback range, an alarm is issued.

NOTE
With the CNC for a lathe, the "VALIABLE M" tab is not displayed.

Measurement motion

<1> A rapid movement is made from the current position to the point specified by "MEAS.STRT PT.X" and "MEAS.STRT PT.Y."
<2> A rapid movement is made in the Z-axis direction to the position ("MEASURE POINT Z"+"APROCH DISTANCE").
<3> A movement is made in the Z-axis direction to "MEASUREMENT POINT Z" at feedrate fb.
<4> A measurement is made in the range from the approach point to ($\alpha + \gamma$ - stylus ball radius r) at feedrate f. (First measurement)
<5> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to ($\beta + \gamma$) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)
<6> A movement is made along the X-axis and Y-axis simultaneously to the position specified by "2ND MEAS.STRT PT.X" and "2ND MEAS.STRT PT.Y."
<7> A measurement is made for the second point in the same way as for the first point.
<8> A return movement is made by "APROCH DISTANCE" in the Z-axis direction.

Coordinate system rotation

If bit 2 of parameter No. 27220 is set to 1, the coordinate system rotation command (G68) is output automatically after measurement.

NOTE
1 To execute the coordinate system rotation command, the option for coordinate system rotation is required.

NOTE

2 Pressing the [ROTATE] soft key executes the following command:

G68 X#[n+1] Y#[n+2] R [#n]

where n represents the macro variable used for setting.
Measure the angle of a slanted workpiece, with the rotation center for coordinate system rotation set beforehand in the variables #(macro variable + 1) and #(macro variable + 2).

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2029 P_ Q_ H_ V_ C_ D_ A_ L_ R_ F_ W_ S_ Y_ U_ K_ E_ ;

Measurement result

When G2029 is executed, the result of measurement is output to the specified macro variable.

Other measurements

Measurement of "ANGLED WORK MEASUREMENT (PROBE X-AXIS)" is the same as for measurement in the probe Z-axis direction.

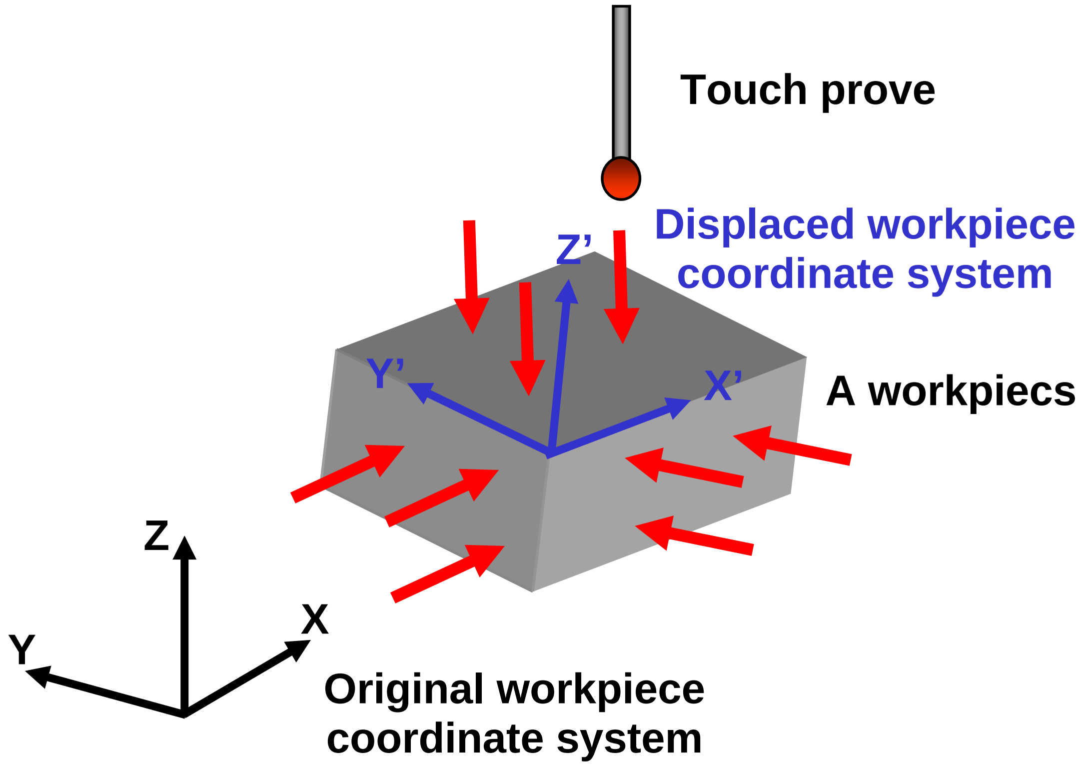
G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2129 P_ Q_ H_ V_ C_ D_ A_ L_ R_ F_ W_ S_ Y_ U_ K_ E_ ;

2.4.12 Workpiece Setting Error Measurement

This function measures three planes (or nine points) of a tilted work, and calculates the workpiece setting error. The calculated workpiece setting error is outputted to CNC and it is possible to use it in the workpiece setting error compensation function.



NOTE
1 The option "Workpiece setting error compensation" is necessary to use this function.
2 The following parameter setting is necessary to use this function.

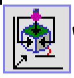
27222#6=1	Workpiece setting error measurement function is available.
27222#7=0	Display Y axis measurement cycle and input data for Y axis direction function.
27253	Set start number of macro variable area (71 and over) for calculating workpiece setting error.

NOTE
1 Only rectangular parallelepiped workpiece can be measured.
2 The measurement range θ of the rotation error is –90° < θ < 90°.
3 Only Z axis direction can be used as the prove axis.
4 It is necessary to perform the following four every cycles.
<1> WORK SETTING ERROR MEASUREMENT(XY)
<2> WORK SETTING ERROR MEASUREMENT(YZ)
<3> WORK SETTING ERROR MEASUREMENT(ZX)
<4> WORK SETTING ERROR MEASUREMENT(SET-WORK)
It is necessary to perform WORK SETTING ERROR MEASUREMENT(SET-WORK) at last.

2.4.13 Work Setting Error Measurement(XY-PLANE)

This function measures three points on the X-Y plane. The measurement result is outputted to the macro variable specified by parameter No.27253.

Data input screen

Select  "WORK SETTING ERROR MEASUREMENT(XY)" on the [SET ERROR] tab of the measurement cycle menu screen.The following input item are displayed.

MEAS.EXEC		
Input item		Meaning
Q	MEASUREMENT COND.(*1)	The measurement condition (group no of measurement condition of WORK SET and MEASURE).
H	1ST MEAS.STRT PT.X	The X coordinate of the measurement position (start position) for the first point.
V	1ST MEAS.STRT PT.Y	The Y coordinate of the measurement position (start position) for the first point.
X	1ST MEAS.STRT PT.Z	The Z coordinate of the measurement position (start position) for the first point.
A	2ND DISTANCE	The distance in the X axis direction from the first point to the second point.
B	3RD DISTANCE	The distance in the Y axis direction from the first point to the third point.
R	APROCH DISTANCE	The move distance from the approach point to the measurement position in the Z direction.
F	MOVING MEAS.SPEED	The feedrate at the measurement.

(*1) When parameter No.27224#5 is set to 1, the address Q is not outputted
(*2) When parameter No.27224#0 is set to 1, the address R is not outputted

Measurement motion

<1> A rapid movement is made from the current position to the point specified by “1ST MEAS.STRT PT.X” and “1ST MEAS.STRT PT.Y”.
<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate). Hear, the approach point (Z coordinate) represents (“1ST MEAS.STRT PT.Z” + “APROCH DISTANCE”)
<3> A movement is made from the approach point to the measurement start point Z at “FEED-RATE FOR APPROACHING START POINT” of the axis direction.
<4> In the Z-axis direction and the range of (“APPROACH DISTANCE FOR 1ST MEASUREMENT”+ γ), a measurement is made at feedrate “FEED-RATE FOR 1ST MEASUREMENT” f1 (First measurement)
<5> Next, a rapid return movement is made by β, and a measurement is made at the feedrate F specified by “MOVING MEAS.SPEED” in the range from that position to (β+ γ). (Second measurement)
<6> A rapid return movement is made to “1ST MEAS.STRT PT.Z”.
<7> A measurement of the second point is made, following the measurement motion from <1> through <6> for the first point.
<8> A measurement of the third point is made, following the measurement motion from <1> through <6> for the first point.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2035 Q_ H_ V_ X_ A_ B_ R_ F_ ;
```

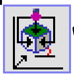
Measurement result

When G2035 is executed, the result of measurement is outputted to macro variables for the result of measurement.

2.4.14 Work Setting Error Measurement(YZ-PLANE)

This function measures three points on the Y-Z plane. The measurement result is outputted to the macro variable specified by parameter No.27253.

Data input screen

Select  "WORK SETTING ERROR MEASUREMENT(YZ) " on the [SET ERROR] tab of the measurement cycle menu screen.The following input item are displayed.

MEAS.EXEC		
Input item		Meaning
Q	MEASUREMENT COND.(*1)	The measurement condition (group no of measurement condition of WORK SET and MEASURE).
M	1ST PT.MEASURE DIRECT	The measurement direction from the first point through third point.
H	1ST MEAS.STRT PT.X	The X coordinate of the measurement position (start position) for the first point.
V	1ST MEAS.STRT PT.Y	The Y coordinate of the measurement position (start position) for the first point.
X	1ST MEAS.STRT PT.Z	The Z coordinate of the measurement position (start position) for the first point.
A	2ND DISTANCE	The distance in the Y axis direction from the first point to the second point.
B	3RD DISTANCE	The distance in the Z axis direction from the first point to the third point.
R	APROCH DISTANCE	The move distance from the approach point to the measurement position in the X direction.
F	MOVING MEAS.SPEED	The feedrate at the measurement.

(*1) When parameter No.27224#5 is set to 1, the address Q is not outputted
(*2) When parameter No.27224#0 is set to 1, the address R is not outputted

Measurement motion

<1> A rapid movement is made from the current position to the point specified by “1ST MEAS.STRT PT.X” and “1ST MEAS.STRT PT.Y”.
<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate). Hear, the approach point (Z coordinate) represents (“1ST MEAS.STRT PT.Z” + “APROCH DISTANCE”)
<3> A movement is made from the approach point to the measurement start point Z at “FEED-RATE FOR APPROACHING START POINT” of the axis direction.
<4> In the X-axis direction and the range of (“APPROACH DISTANCE FOR 1ST MEASUREMENT”+ γ), a measurement is made at feedrate “FEED-RATE FOR 1ST MEASUREMENT” f1 (First measurement)
<5> Next, a rapid return movement is made by β, and a measurement is made at the feedrate F specified by “MOVING MEAS.SPEED” in the range from that position to (β+ γ). (Second measurement)
<6> A rapid return movement is made to “1ST MEAS.STRT PT.X”.
<7> A measurement of the second point is made, following the measurement motion from <1> through <6> for the first point.
<8> A measurement of the third point is made, following the measurement motion from <1> through <6> for the first point.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2036 Q_ M_ H_ V_ X_ A_ B_ R_ F_ ;

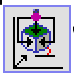
Measurement result

When G2036 is executed, the result of measurement is outputted to macro variables for the result of measurement.

2.4.15 Work Setting Error Measurement(ZX-PLANE)

This function measures three points on the Z-X plane. The measurement result is outputted to the macro variable specified by parameter No.27253.

Data input screen

Select  "WORK SETTING ERROR MEASUREMENT(ZX)" on the [SET ERROR] tab of the measurement cycle menu screen.The following input item are displayed.

MEAS.EXEC		
Input item		**Meaning**
Q	MEASUREMENT COND.(*1)	The measurement condition (group no of measurement condition of WORK SET and MEASURE).
H	1ST MEAS.STRT PT.X	The X coordinate of the measurement position (start position) for the first point.
V	1ST MEAS.STRT PT.Y	The Y coordinate of the measurement position (start position) for the first point.
X	1ST MEAS.STRT PT.Z	The Z coordinate of the measurement position (start position) for the first point.
A	2ND DISTANCE	The distance in the X axis direction from the first point to the second point.
B	3RD DISTANCE	The distance in the Z axis direction from the first point to the third point.
R	APROCH DISTANCE	The move distance from the approach point to the measurement position in the Y direction.
F	MOVING MEAS.SPEED	The feedrate at the measurement.

(*1) When parameter No.27224#5 is set to 1, the address Q is not outputted
(*2) When parameter No.27224#0 is set to 1, the address R is not outputted

Measurement motion

<1> A rapid movement is made from the current position to the point specified by “1ST MEAS.STRT PT.X” and “1ST MEAS.STRT PT.Y”.
<2> In the Z-axis direction, a rapid movement is made to the approach point (Z coordinate). Hear, the approach point (Z coordinate) represents (“1ST MEAS.STRT PT.Z” + “APROCH DISTANCE”)
<3> A movement is made from the approach point to the measurement start point Z at “FEED-RATE FOR APPROACHING START POINT” of the axis direction.
<4> In the Y-axis direction and the range of (“APPROACH DISTANCE FOR 1ST MEASUREMENT”+ γ), a measurement is made at feedrate “FEED-RATE FOR 1ST MEASUREMENT” f1 (First measurement)
<5> Next, a rapid return movement is made by β, and a measurement is made at the feedrate F specified by “MOVING MEAS.SPEED” in the range from that position to (β+ γ). (Second measurement)
<6> A rapid return movement is made to “1ST MEAS.STRT PT.Y”.
<7> A measurement of the second point is made, following the measurement motion from <1> through <6> for the first point.
<8> A measurement of the third point is made, following the measurement motion from <1> through <6> for the first point.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2037 Q_ M_ H_ V_ X_ A_ B_ R_ F_ ;

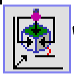
Measurement result

When G2037 is executed, the result of measurement is outputted to macro variables for the result of measurement.

2.4.16 Work Setting Error Measurement(Set-work)

This function calculates the workpiece setting error. The calculation result is outputted to the specified macro variable.

Data input screen

Select  "WORK SETTING ERROR MEASUREMENT(SET-WORK)" on the [SET ERROR] tab of the measurement cycle menu screen.The following input item are displayed.

MEAS.EXEC		
Input item		Meaning
W	WORK SETTING ERR.NO	A workpiece setting error number for storing the measurement result. If omitted, the calculation result is not set to “SETTING DEST.” (workpiece setting error).
U	CORNER COORD.VALUE(X)	The X coordinate of the correct corner position.A corner where the three measured planes intersect is a target.
E	CORNER COORD.VALUE(Y)	The Y coordinate of the correct corner position.A corner where the three measured planes intersect is a target.
C	CORNER COORD.VALUE(Z)	The Z coordinate of the correct corner position.A corner where the three measured planes intersect is a target.
S	OK RANGE (*1) (*2)	An allowable range of measurement error for ignoring the measurement result.If the difference between the obtained corner coordinate as the result of measurement and the correct corner coordinate value is within this allowable range, the absence of errors is assumed, and no setting is performed as a macro variable.
Y	FEED BACK RANGE	If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination. If an error obtained from measurement exceeds the feedback range, an alarm is issued.

(*1) When parameter No.27224#1 is set to 1, the address S and Y are not outputted
(*2) Because of not required input item, if not inputted, the address W, S and Y are not outputted.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2038 W_ U_ E_ C_ S_ Y_ ;
```

Measurement result

When G2038 is executed, the result of measurement is outputted to macro variables for the result of measurement.

Set workpiece setting error

After the calculation is finished normally, the workpiece setting error in NC is updated. It is necessary to fulfill the following condition.

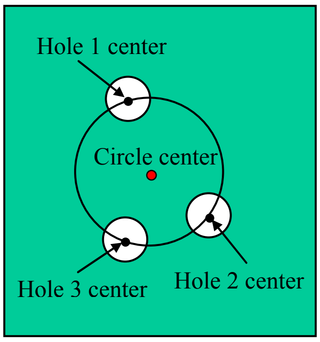
<1> WORKPIECE SETTING ERROR NO. is specified.

<2> The difference between the obtained corner coordinate as the result of measurement and the correct corner coordinate value is not within the OK range. Or the OK range is not specified.

<3> The FEED BACK RANGE is specified, and the difference between the obtained corner coordinate as the result of measurement and the correct corner coordinate value is within the FEED BACK range.

2.4.17 Measuring Center of Circle by 3 Holes (WORK SET) (for Series 30*i*/31*i*/32*i*-B, 0*i*-F/0*i*-D)

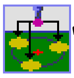
Center of circle by center of 3 holes can be measured.
Measurement results are set into the workpiece origin offset automatically.



2.4.17.1 Parameter setting for use of cycle

Set parameter No.27221#6=1.

2.4.17.2 Method of creating cycle

Select  "CIRCLE BY 3 HOLES(PROBE Z)" on the [WORK SET] tab of the measurement cycle menu screen. The window for creating cycle is appears. Input the following item according to guidance drawing.

(1) [MOTION]tab

Input item		Meaning
Q	MEASUREMENT COND.	Measurement condition (centering measurement condition group number)
D	HOLE DIA.	Diameter of hole 1, hole 2 and hole 3
L	HEIGHT OF MEAS.PT.	Height of a measurement position in the Z-axis direction
R	APROCH DISTANCE	Move distance from the approach point to a measurement position in the Z-axis direction
F	MOVING MEAS.SPEED	Feedrate for measurement
P	MEASUREMENT POINT	Number of measurement points (3 to 4)
M	SPINDLE ORIENTATION	Enable or disable of "spindle orientation" of each measurement point

(2) [MEAS. POS.]tab

Input item		Meaning
H	CENTER OF HOLE1(X)	X of the center position of hole 1
V	CENTER OF HOLE1(Y)	Y of the center position of hole 1
X	CENTER OF HOLE2(X)	X of the center position of hole 2
Y	CENTER OF HOLE2(Y)	Y of the center position of hole 2
W	CENTER OF HOLE3(X)	X of the center position of hole 3
Z	CENTER OF HOLE3(Y)	Y of the center position of hole 3

(3) [WORK M] / [WORK T]tab

Input item		Meaning
U	SETTING DEST.(M) / SETTING DEST.(T)	Number of workpiece origin offset for storage of the measurement result
A	WORK COORD.VALUE X	X of measurement position on the specified workpiece coordinate system
B	WORK COORD.VALUE Y	Y of measurement position on the specified workpiece coordinate system
I	CENTER OF CIRCLE(X)	Target value of center position of circle by center hole 1, hole 2 and hole 3 (X coordinate value)
J	CENTER OF CIRCLE(Y)	Target value of center position of circle by center hole 1, hole 2 and hole 3 (Y coordinate value)
K	OK RANGE(±)	Specify an allowable range of measurement errors. If the following difference is within OK range, the result of measurement is not set into workpiece origin offset. · Difference between center position of the circle from measurement and the target value of center position of the circle
E	FEED BACK RANGE(±)	Specify the feed back range of measurement errors. (Measurement errors are feedback range from OK range) The result of measurement is set into workpiece origin offset. (Measurement errors are greater than feedback range) Alarm is displayed.

(*1) [WORK M] tab is displayed when CNC is for machining center.
(*2) [WORK T] tab is displayed when CNC is for lathe.

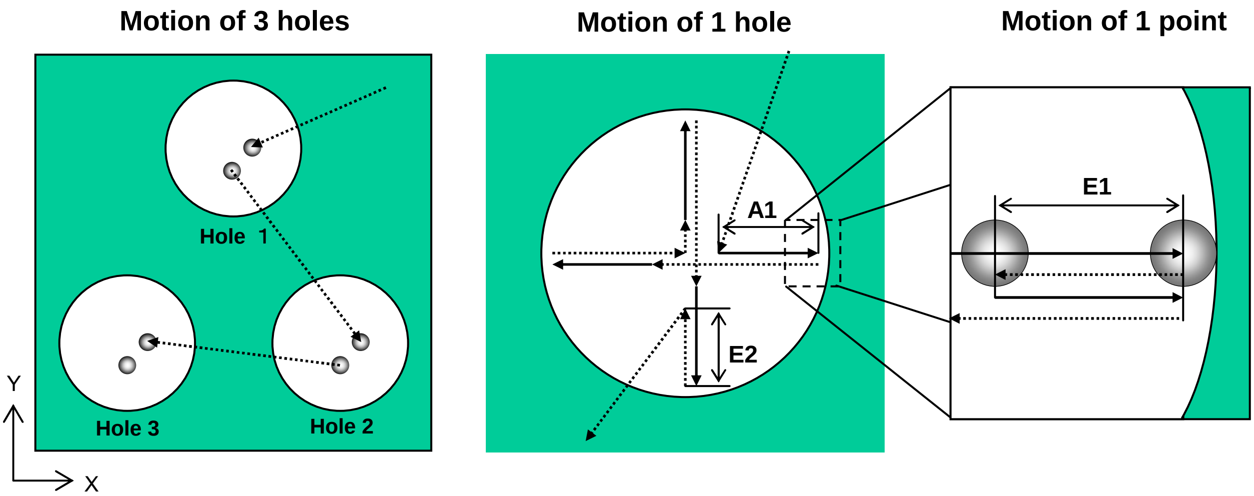
2.4.17.3 Program format

When INSERT key is pressed after entering necessary data in window for creating cycle, the following program is created.

G2320 Qq Dd Ll Rr Ff Pp Mm Hh Vv Xx Yy Ww Zz Uu Aa Bb Ii Jj Kk Ee;

2.4.17.4 Measurement motion

(XY-PLANE)



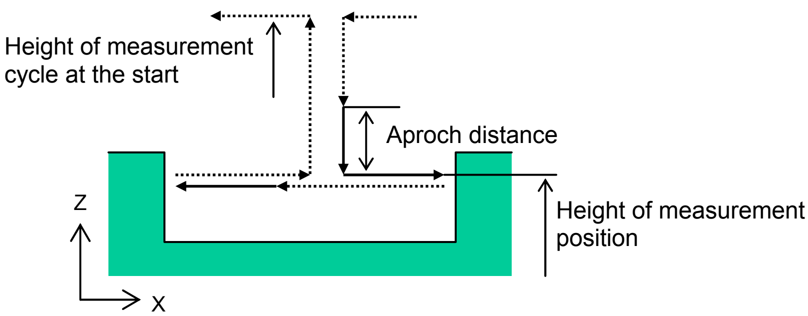
········▸ :	Rapid movement
──────▸ :	G31

Data to be set in the measurement setting screens

A1 : Approach distance for 1st measurement
E1 : Escape distance for 1st measurement
E2 : Escape distance for 2nd measurement

(XZ-PLANE)

Motion of 1 hole

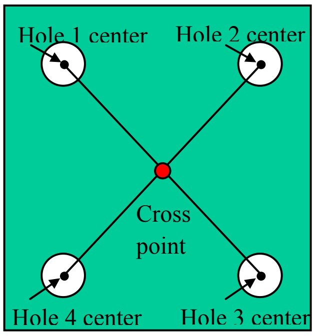


2.4.17.5 Measurement result

When G2320 is executed, measurement results are set into the workpiece origin offset automatically.

2.4.18 Measuring Cross of Diagonal by 4 Holes (WORK SET) (for Series 30*i*/31*i*/32*i*-B, 0*i*-F/0*i*-D)

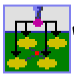
Cross point of diagonal by center of 4 holes can be measured.
Measurement results are set into the workpiece origin offset automatically.



2.4.18.1 Parameter setting for use of cycle

Set parameter No.27221#6=1.

2.4.18.2 Method of creating cycle

Select "DIAGONAL BY 4 HOLES(PROBE Z)" on the [WORK SET] tab of the measurement cycle menu screen. The window for creating cycle is appears. Input the following item according to guidance drawing.

(1) [MOTION]tab

Input item		Meaning
Q	MEASUREMENT COND.	Measurement condition (centering measurement condition group number)
D	HOLE DIA.	Diameter of hole 1, hole 2, hole 3 and hole 4
L	HEIGHT OF MEAS.PT.	Height of a measurement position in the Z-axis direction
R	APROCH DISTANCE	Move distance from the approach point to a measurement position in the Z-axis direction
F	MOVING MEAS.SPEED	Feedrate for measurement
P	MEASUREMENT POINT	Number of measurement points (3 to 4)
M	SPINDLE ORIENTATION	Enable or disable of "spindle orientation" of each measurement point

(2) [MEAS. POS.]tab

Input item		Meaning
H	CENTER OF HOLE1(X)	X of the center position of hole 1
V	CENTER OF HOLE1(Y)	Y of the center position of hole 1
X	CENTER OF HOLE2(X)	X of the center position of hole 2
Y	CENTER OF HOLE2(Y)	Y of the center position of hole 2
W	CENTER OF HOLE3(X)	X of the center position of hole 3
Z	CENTER OF HOLE3(Y)	Y of the center position of hole 3
C	CENTER OF HOLE4(X)	X of the center position of hole 4
S	CENTER OF HOLE4(Y)	Y of the center position of hole 4

(3) [WORK M] / [WORK T]tab

Input item		Meaning
U	SETTING DEST.(M) / SETTING DEST.(T)	Number of workpiece origin offset for storage of the measurement result
A	WORK COORD.VALUE X	X of measurement position on the specified workpiece coordinate system
B	WORK COORD.VALUE Y	Y of measurement position on the specified workpiece coordinate system
I	CROSS OF DIAG.(X)	Target value of cross of diagonal by center hole 1 from hole 3 and diagonal by center hole 2 from hole 4 (X coordinate value)
J	CROSS OF DIAG.(Y)	Target value of cross of diagonal by center hole 1 from hole 3 and diagonal by center hole 2 from hole 4 (Y coordinate value)
K	OK RANGE(±)	Specify an allowable range of measurement errors. If the following difference is within OK range, the result of measurement is not set into workpiece origin offset. ・ Difference between cross position of diagonal from measurement and the target value of cross position of diagonal.
E	FEED BACK RANGE(±)	Specify the feed back range of measurement errors. (Measurement errors are feedback range from OK range) The result of measurement is set into workpiece origin offset. (Measurement errors are greater than feedback range) Alarm is displayed.

(*1) [WORK M] tab is displayed when CNC is for machining center.
(*2) [WORK T] tab is displayed when CNC is for lathe.

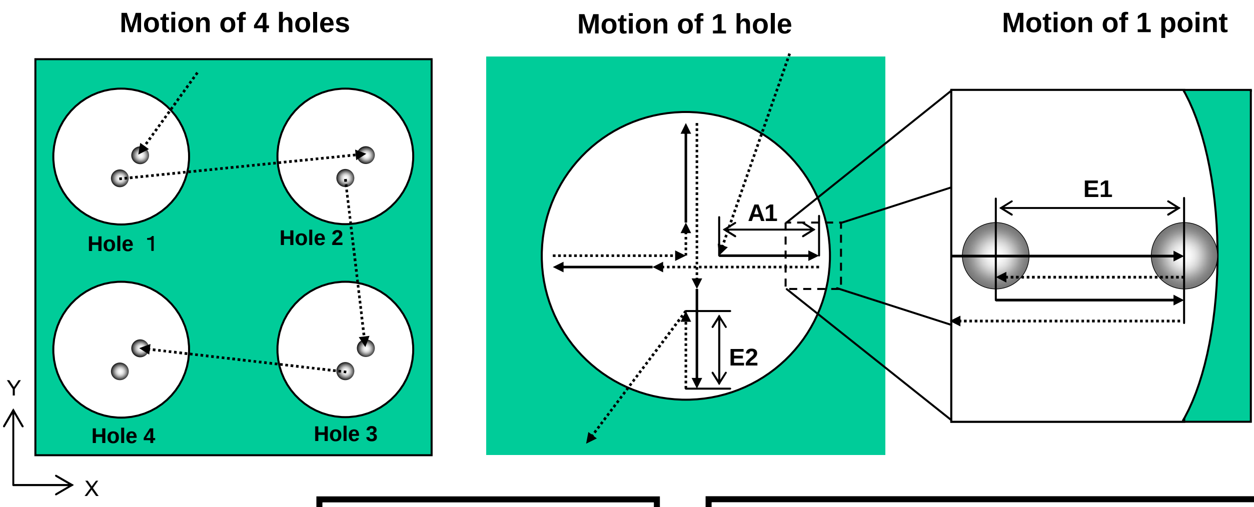
2.4.18.3 Program format

When INSERT key is pressed after entering necessary data in window for creating cycle, the following program is created.

G2321 Qq Dd Ll Rr Ff Pp Mm Hh Vv Xx Yy Ww Zz Cc Ss Uu Aa Bb Ii Jj Kk Ee;

2.4.18.4 Measurement motion

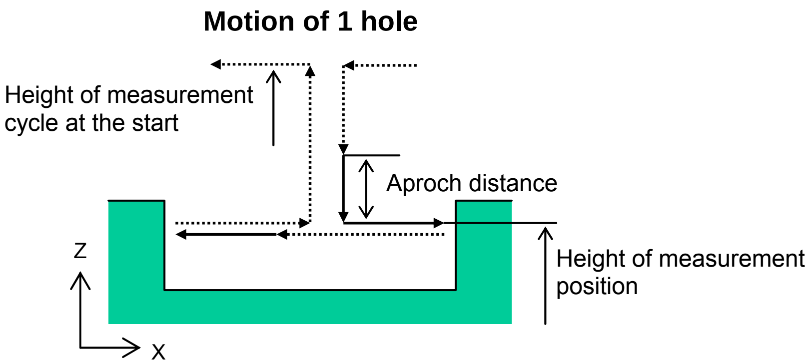
(XY-PLANE)



┈┈▸ : Rapid movement
──▸ : G31

Data to be set in the measurement setting screens
A1 : Approach distance for 1st measurement
E1 : Escape distance for 1st measurement
E2 : Escape distance for 2nd measurement

(XZ-PLANE)



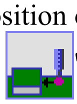
2.4.18.5 Measurement result

When G2321 is executed, measurement results are set into the workpiece origin offset automatically.

2.5 MEASURE (PROBE Z-AXIS DIRECTION)

2.5.1 End Face (X-axis Direction) Measurement

The position of an end face in the X-axis direction is measured.

Select  "X-AXIS DIRECTION MEASUREMENT(PROBE Z-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

The detailed descriptions of the input items are the same as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)".

[T-TOOL] tab

This screen is the input screen (for turning) used for automatic tool offset setting.
This screen enables specification for setting a measured value as a tool offset value on the turning side.

NOTE
With the CNC for a machining center, the [T-TOOL] tab is not displayed.

- COMP. NUMBER T

Enter the number corresponding to a tool offset value for which a measurement result is set by using a numeric value.
When this item is not entered, the result of measurement is not set as a tool offset value.

- SETTING DEST. (T)

Select a tool offset item for setting the result of measurement, from the soft keys.

- OK RANGE (±)

Enter an allowable range of errors obtained from measurement, by specifying a numeric value.
If the difference between the obtained result of measurement and the specified coordinate value (input values for "MEASURE POINT X") is within this allowable range, the absence of errors is assumed, and no setting is performed as a tool offset value.

- FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.

Processing when the OK range and the feedback range are 0

The same processing as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)" is performed.

[M-TOOL] tab

This screen is the input screen (for milling) used for automatic tool offset setting.
This screen enables specification for setting a measured value as a tool offset value on the milling side.

NOTE
With the CNC for a lathe, the [M-TOOL] tab is not displayed.

SETTING DEST. (M)

Select a tool offset item for setting the result of measurement, from the soft keys.
The contents of the other items are the same as for the [T-TOOL] tab described earlier.

Measurement motion

The description is the same as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS).

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

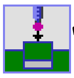
```
G2040 Q_ P_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2040 is executed, the compensation value obtained from the measured value is output to macro variables for the result of measurement and as a tool offset value.

2.5.2 End Face (Y-axis Direction) Measurement

The position of an end face in the Y-axis direction is measured.

Select  "Y-AXIS DIRECTION MEASUREMENT(PROBE Z-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

As the window title, "Y-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)" is indicated.
The other displayed items are the same as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)".
The detailed descriptions of the input items are the same as for "Y-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)".

[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)."

Measurement motion

The description of measurement motion is the same as for "Y-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)".

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

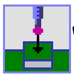
```
G2041 Q_ P_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2041 is executed, the compensation value obtained from the measured value is output to macro variables for the result of measurement and as a specified tool offset value.

2.5.3 End Face (Z-axis Direction) Measurement

The position of an end face in the Z-axis direction is measured.

Select  "Z-AXIS DIRECTION MEASUREMENT(PROBE Z-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

As the window title, "Z-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)" is indicated.
The other displayed items are the same as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)".
The descriptions of the input items are the same as for "Z-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)".

[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for “X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS).”

Measurement motion

The description of measurement motion is the same as for "Z-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)".

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

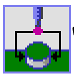
```
G2042 Q_ P_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2042 is executed, the compensation value obtained from the measured value is output to macro variables for the result of measurement and as a specified tool offset value.

2.5.4 Outside Diameter Measurement

When the probe is oriented in the Z-axis direction, the outside diameter and center position of a circle is measured.

Select  "OUTSIDE DIAMETER MEASUREMENT(PROBE Z-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT POINT

Enter the number of measurement points by specifying a numeric value.

The descriptions of the other items are the same as for "OUTSIDE DIAMETER WORK SETUP (PROBE Z-AXIS)".

[T-TOOL] tab

This screen is the input screen (for turning) used for automatic tool offset setting.

This screen enables specification for setting a measured value as a tool offset value on the turning side.

> **NOTE**
> With the CNC for a machining center, the [T-TOOL] tab is not displayed.

- OK RANGE (±)

Enter an allowable range of errors obtained from measurement, by specifying a numeric value.If the difference between the outside diameter that calculates from the measured coordinate values of three points or four points and the correct value (input value "OUTSIDE DIAMETER") is within this allowable range, the absence of errors is assumed, and no setting is performed as a workpiece origin offset value.

- FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination.

If an error obtained from measurement exceeds the feedback range, an alarm is issued.

The other input items are the same as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)".

Processing when the OK range and the feedback range are 0

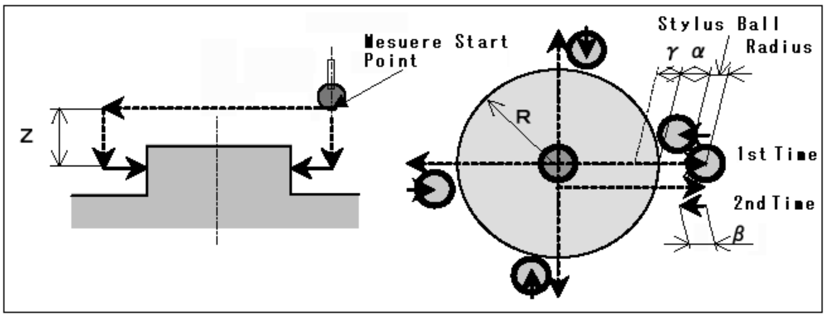
The description of processing is the same as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)".

[M-TOOL] tab

This screen is the input screen (for milling) used for automatic tool offset setting.
The descriptions of the input items are the same as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)".

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT X" + ("OUTSIDE DIAMETER"/2 + α +r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<2> In the Z-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<3> In the -Z-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<4> If "ON" is selected for "SPINDLE ORIENTATION", spindle orientation is performed here.
<5> In the range of (α + γ), a measurement is made at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by ε, and a rapid return movement is made in the Z-axis direction to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<7> A rapid movement is made to "CENTER POINT X", then a movement is made in the -X-axis direction by the distance ("OUTSIDE DIAMETER"/2 + α + r) at feedrate fa.
<8> A similar measurement is made in the -X-axis direction and ±Y-axis directions.
<9> After of the first measurement, a center position for the second measurement is calculated from the measurement result of each point.
<10>In the +X-axis direction, a movement is made at feedrate fa to the position (measurement position of the first measurement + β), then a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<11>Next, a rapid return movement is made by ε, then a rapid return movement is made in the Z-axis direction to the position before the start of measurement.
<12>A rapid movement is made to the center X coordinate before the start of measurement, then a similar measurement is made in the -X-axis direction and ±Y-axis directions.

When bit 3 (SHRT) of parameter No. 12380 = 1
<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT X" + ("OUTSIDE DIAMETER"/2 + α +r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<2> In the Z-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<3> In the -Z-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<4> If "ON" is selected for "SPINDLE ORIENTATION", spindle orientation is performed here.

<5> In the range of ($\alpha + \gamma$), a measurement is made at feedrate f. (First measurement)

<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to ($\beta + \gamma$). (Second measurement)

<7> Next, a rapid return movement is made by ε, and a rapid return movement is made in the Z-axis direction to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<8> A rapid movement is made to "CENTER POINT X", then a movement is made in the -X-axis direction by the distance ("OUTSIDE DIAMETER"/2 + α + r) at feedrate fa.

<9> A similar measurement is made in the -X-axis direction and ±Y-axis directions.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of “APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

Motion depending on the number of measurement points

When "MEASUREMENT POINT" is set to 1, a measurement is made in the +X-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +X-axis and -X-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +X-axis, -X-axis, and +Y-axis directions.

When bit 0 (CRY) of parameter No. 12380 is set to 1, however, a measurement is made as follows:
When "MEASUREMENT POINT" is set to 1, a measurement is made in the +Y-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +Y-axis and –Y-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +Y-axis, -Y-axis, and +X-axis directions only.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

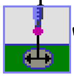
```
G2043 Q_ D_ H_ V_ L_ R_ F_ P_ M_ W_ I_ J_ S_ Y_ U_ A_ B_ K_ E_ ;
```

Measurement result

When G2043 is executed, the diameter of the circle is found from the measured value, and the compensation value obtained from the difference is output to macro variables for the result of measurement and as a specified tool offset value.

2.5.5 Inside Diameter Measurement

When the probe is oriented in the Z-axis direction, the inside diameter of a circle is measured.

Select  "INSIDE DIAMETER MEASUREMENT(PROBE Z-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

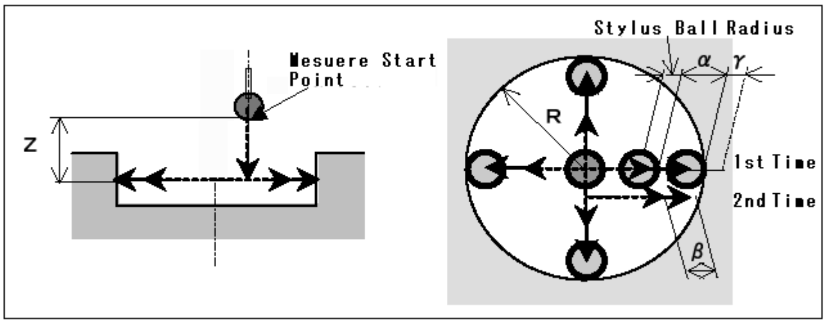
The descriptions of the input items are the same as for "Outside Diameter Measurement".

[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for “OUTSIDE DIAMETER MEASUREMENT(PROBE Z-AXIS).”

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT X" + ("INSIDE DIAMETER"/2 - α - r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<2> In the Z-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<3> In the -Z-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<4> If "ON" is selected for "SPINDLE ORIENTATION", spindle orientation is performed here.
<5> In the range of (α + γ) from that point, a measurement is made at feedrate f. (First measurement)
<6> Then, a rapid return movement is made by β, and a rapid movement is made to the X coordinate specified by "CENTER POINT X", then a movement is made in the -X-axis direction by the distance ("INSIDE DIAMETER"/2 - α -r) at feedrate fa.
<7> A similar measurement is made in the -X-axis direction and ±Y-axis directions.
<8> After of the first measurement, a center position for the second measurement is calculated from the measurement result of each point.
<9> In the +X-axis direction, a movement is made at feedrate fa to the position (measurement position of the first measurement - β), then a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<10>A similar measurement is made in the -X-axis direction and ±Y-axis directions.
<11>In the Z-axis direction, a return movement is made by "APROCH DISTANCE".

When bit 3 (SHRT) of parameter No. 12380 = 1
<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT X" + ("INSIDE DIAMETER"/2 - α - r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<2> In the Z-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<3> In the -Z-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<4> If "ON" is selected for "SPINDLE ORIENTATION", spindle orientation is performed here.
<5> In the range of ($\alpha + \gamma$), a measurement is made at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to ($\beta + \gamma$). (Second measurement)
<7> After a rapid return movement is made by ε, a rapid movement is made to the X coordinate specified by " CENTER POINT X ", then a movement is made at feedrate fa in the -X-axis direction by the distance ("INSIDE DIAMETER"/2 - α - r).
<8> A similar measurement is made in the -X-axis direction and ±Y-axis directions.
<9> In the Z-axis direction, a return movement is made by "APROCH DISTANCE".

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of “APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

Motion depending on the number of measurement points

The description is the same as for "Outside Diameter Measurement".

Motion when spindle orientation is enabled

The description is the same as for "Outside Diameter Measurement".

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

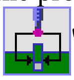
```
G2044 Q_ D_ H_ V_ L_ R_ F_ P_ M_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2044 is executed, the diameter of the circle is found from the measured value, and the compensation value obtained from the difference is output to macro variables for the result of measurement and as a specified tool offset value.

2.5.6 Outside Width Measurement

When the probe is oriented in the Z-axis direction, the width of a projection is measured.

Select  "OUTSIDE WIDTH MEASUREMENT(PROBE Z-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

The displayed items are the same as for "OUTSIDE WIDTH WORK SETUP (PROBE Z-AXIS)".

[T-TOOL] tab

This screen is the input screen (for turning) used for automatic tool offset setting.
This screen enables specification for setting a measured value as a tool offset value on the turning side.

NOTE
With the CNC for a machining center, the [T-TOOL] tab is not displayed.

- OK RANGE (±)

Enter an allowable range of errors obtained from measurement, by specifying a numeric value.
If the difference between the obtained result of measurement and the specified value (input value "PROJECTION WIDTH") is within this allowable range, the absence of errors is assumed, and no setting is performed as a tool offset value.

- FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.
The descriptions of the other input items are the same as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)".

Processing when the OK range and the feedback range are 0

The description of processing is the same as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)".

[M-TOOL] tab

This screen is the input screen (for milling) used for automatic tool offset setting.
The descriptions of the input items are the same as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)".

Measurement motion

The description of measurement motion is the same as for "OUTSIDE WIDTH WORK SETUP (PROBE Z-AXIS)".

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

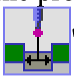
G2045 P_ Q_ D_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;

Measurement result

When G2045 is executed, the projection width is found from the measured value, and the compensation value obtained from the difference is output to macro variables for the result of measurement and as a tool offset value.

2.5.7 Inside Width Measurement

When the probe is oriented in the Z-axis direction, the width of a groove is measured.

Select  "INSIDE WIDTH MEASUREMENT(PROBE Z-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

The displayed items are the same as for "INSIDE WIDTH WORK SETUP (PROBE Z-AXIS)".

[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for “OUTSIDE WIDTH MEASUREMENT(PROBE Z-AXIS).”

Measurement motion

The description of measurement motion is the same as for "INSIDE WIDTH WORK SETUP (PROBE Z-AXIS)".

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2046 P_ Q_ D_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

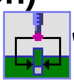
When G2046 is executed, the groove width is found from the measured value, and the compensation value obtained from the difference is output to macro variables for the result of measurement and as a specified tool offset value.

2.5.8 Outside Width/Inside Width Measurement (with a Slant Angle)

When a groove or a projection is slanted, the width can be measured.

> **NOTE**
> 1 This function is enabled when bit 5 (GANG) of parameter No. 27220 is set to 1.
> 2 This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

Data input screen (example of outside width measurement in the probe Z-axis direction)

Select  "OUTSIDE WIDTH MEASUREMENT (PROBE Z-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The following data input items appear:

MEASURE		
Input item		Meaning
Q	MEASUREMENT COND.	Measurement condition (centering measurement condition group number)
D	PROJECTION WIDTH	Correct projection width
H	INTERNAL POINT X	X coordinate of the center position at measurement time
V	INTERNAL POINT Y	Y coordinate of the center position at measurement time
M	SLANT ANGLE	Slant angle of a groove or projection. (Counterclockwise rotation represents a plus angle, with the +X-axis representing 0°.)
L	HEIGHT OF MEAS.PT.	Height of a measurement position in the Z-axis direction
R	APROCH DISTANCE	Move distance from the approach point to a measurement position in the Z-axis direction
F	MOVING MEAS.SPEED	Feedrate at measurement time

T-TOOL		
Input item		Meaning
W	COMP.NUMBER T	Offset number for storing the result of measurement
I	SETTING DEST. T	Set data such as figure, wear, and length compensation.
S	OK RANGE (±)	Specify an allowable range of measurement errors for ignoring the result of measurement. If the difference between the projection width obtained from measurement and the correct width is within this range, the difference is treated as an allowable error and the result of measurement is not set in a macro variable.
Y	FEED BACK RANGE (±)	If an error obtained from the result of measurement is in the range from the OK range to this feedback range, the result of measurement is set in the setting destination. If an obtained error exceeds the feedback range, an alarm is issued.

NOTE

With the CNC for a machining center, the [T-TOOL] tab is not displayed.

M-TOOL		
Input item		Meaning
U	COMP.NUMBER M	Offset number for storing the result of measurement
J	SETTING DEST. T	Set data such as figure, wear, and length compensation.
K	OK RANGE (±)	Specify an allowable range of measurement errors for ignoring the result of measurement. If the difference between the projection width obtained from measurement and the correct width is within this range, the difference is treated as an allowable error and the result of measurement is not set in a macro variable.
E	FEED BACK RANGE (±)	If an error obtained from the result of measurement is in the range from the OK range to this feedback range, the result of measurement is set in the setting destination. If an obtained error exceeds the feedback range, an alarm is issued.

NOTE

With the CNC for a lathe, the [M-TOOL] tab is not displayed.

Measurement motion (example of outside width measurement in the probe Z-axis direction)

<1> A measurement is made from the current position in the direction normal to an input angle. The first point is measured in the direction of a smaller angle, with the +X-axis direction representing 0°. A rapid movement is made to the position ("CENTER PT."+("PROJECTION WIDTH"/2+α+r)) at right angles to the projection.

<2> A rapid movement is made in the Z-axis direction to the approach point ("HEIGHT OF MEAS.PT."+"APROCH DISTANCE").

<3> A movement is made in the -Z-axis direction to the position specified by "HEIGHT OF MEAS.PT." at feedrate Fb then a measurement is made at feedrate f in the range from that position to ($\alpha + \gamma$). (First measurement)

<4> Next, a rapid return movement is made by β then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to ($\beta + \gamma$). (Second measurement)

<5> Next, a rapid return movement is made by ε then a rapid return movement is made in the Z-axis direction to the approach point ("HEIGHT OF MEAS.PT."+"APROCH DISTANCE").

<6> Then, after a rapid movement is made to the center coordinates and a movement is made to the approach point on the - side at feedrate Fa, a similar measurement is made in the -X-axis (-Y-axis) direction as well.

G code format (example of outside width measurement in the probe Z-axis direction)

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2045 Q_ D_ H_ V_ M_ L_ R_ F_ W_ T_ X_ B_ I_ S_ Y_ U_ C_ Z_ A_ J_ K_ E_ ;
```

Measurement result (example of outside width measurement in the probe Z-axis direction)

When G2045 is executed, the result of measurement is output as a specified tool offset.

Others

- The three-dimensional slant of a plane cannot be measured.
- No slant measurement based on C-axis operation can be made.

> **NOTE**
> This function is disabled when bit 7 (NOY) of parameter No. 27222 is set to 1.

Other measurements

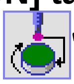
The other outside width/inside width measurements are made in the same way.

2.5.9 Outside Diameter Measurement (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the outside diameter of the circle is obtained from the average of the results.

> **NOTE**
> This function is enabled when bit 0 (RCR) of parameter No. 27222 is set to 1.

[MOTION] tab

Select  "OUTSIDE DIA. MEASUREMENT-WORK ROTATION (PROBE Z)"on the [MEASURE] tab of the measurement cycle menu screen. The measurement operation setting screen appears.

- MEASUREMENT COND.

Enter a measurement condition group number to be referenced at measurement time, by specifying a numeric value.

- OUTER
Enter the correct outside diameter of a circle by specifying a numeric value.

- CENTER POINT X
Enter the X coordinate of the center of a circle by specifying a numeric value.

- CENTER POINT Y
Enter the Y coordinate of the center of a circle by specifying a numeric value.

- HEIGHT OF MEAS. PT.
Enter the height of a measurement position in the Z-axis direction by specifying a numeric value.

- APROCH DISTANCE
Enter the move distance from the approach point to a measurement position in the Z-axis direction by specifying a numeric value.

- STARTING ANGLE
Enter the positioning angle for measurement of the first point by specifying a numeric value.
An angle satisfying "-360° < angle < 360°" may be specified.

- PITCH ANGLE
Enter the pitch angle between measurement points by specifying a numeric value. An angle satisfying "0° < angle < 360°" may be specified.

- MOVING MEAS. SPEED
Enter a feedrate for measurement by specifying a numeric value.

- MEASUREMENT POINT
Enter the number of measurement points by specifying a numeric value. Up to four points may be specified.
This item may not be specified. If this item is not specified, measurements are made from "STARTING ANGLE" at intervals of "PITCH ANGLE" until 360° is reached.

[T-TOOL] tab
This screen enables measurement values to be set as turning tool offset values.

> **NOTE**
> With the CNC for a machining center, the [T-TOOL] tab is not displayed.

- OK RANGE (±)
Specify an allowable range of errors obtained from measurement. If the difference between the outside diameter that calculates from the measured coordinate values of three points or four points and the correct value (value of the input item "OUTER") is within this range, the presence of no error is assumed, resulting in no setting as a tool offset value. Enter a numeric value.

- FEED BACK RANGE (±)
If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination. If an error obtained from measurement exceeds the feedback range, an alarm is issued. Enter a numeric value.

The other input items are the same as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)."

Processing when the OK range and the feedback range are 0

The same processing as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)" is performed.

[M-TOOL] tab

This screen enables measurement values to be set as milling tool offset values.

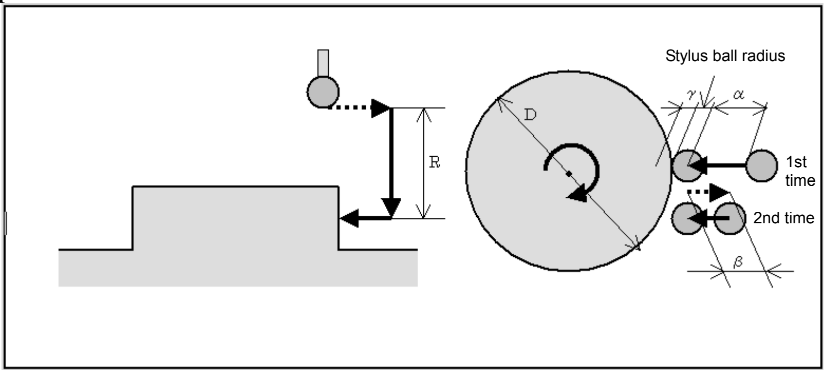
> **NOTE**
> With the CNC for a lathe, the [M-TOOL] tab is not displayed.

The other contents are the same as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)."

Measurement motion

- When rotation axis positioning based on C-axis rotation is used

A measurement operation with the -X direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified by “STARTING ANGLE.”

<2> A rapid movement is made from the current position to the point specified by ("CENTER POINT X"+("OUTER"/2+α+r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction.

<3> A rapid movement is made in the Z-axis direction to the approach point (“HEIGHT OF MEAS.PT.”+”APROCH DISTANCE”).

<4> A movement is made in the -Z-axis direction to the position specified by “HEIGHT OF MEAS.PT.” at feedrate fb.

<5> A measurement is made in the range (α + γ) at feedrate f. (First measurement)

<6> Next, a rapid return movement is made by β then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to (β + γ). (Second measurement)

<7> A rapid return movement is made to the approach point in the X-axis direction.

<8> The C-axis is rotated by the angle specified by “PITCH ANGLE.”

<9> Steps <5> through <8> above are repeated as many times as specified by “MEASUREMENT POINT.”

<10>Finally, a rapid return movement is made to the approach point ("HEIGHT OF MEAS.PT."+"APROCH DISTANCE") along the Z-axis.

> **NOTE**
> Specify a measurement direction in parameter No. 27230.

Meaning	Symbol in the explanation
Feed-rate for approaching start point (in the axis direction)	fb
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ

Meaning	Symbol in the explanation
Escaping distance for 2nd measurement	ε
Stylus ball diameter/2	r

NOTE

The values of α, β, γ, ε, fb, f are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

- When rotation axis positioning based on the spindle orientation function is used

The same measurement procedure as for C-axis rotation is used, except that rotation axis positioning is performed using the spindle orientation function.

If the setting of "STARTING ANGLE" or "PITCH ANGLE" is improper so that the output of a spindle orientation M code for positioning at a proper angle is disabled, the alarm "CANNOT MOVE TO THE SPECIFIED ANGLE" is issued at program execution time.

NOTE

1 Specify spindle orientation M codes in parameter No. 27240 through No. 27245.
2 When using the spindle orientation function, specify "90" or "120" in "PITCH ANGLE." In "STARTING ANGLE," specify an angle that matches the spindle orientation M codes specified in the parameters.
3 Specify bit 0 (SRO) of parameter No. 27223 to set whether to use C-axis positioning or the spindle orientation function for rotation axis positioning.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2053 Q_ D_ H_ V_ L_ R_ N_ M_ F_ P_

Measurement result

When G2053 is executed, the diameter of the circle is found from the average of the measurement results of individual measurement points then the offset value obtained from the differential from the target value (input item "OUTER") is output to the specified tool offset item and macro variable for the result of measurement.

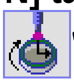
2.5.10 Inside Diameter Measurement (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the inside diameter of the circle is obtained from the average of the results.

NOTE

This function is enabled when bit 0 (RCR) of parameter No. 27222 is set to 1.

[MOTION] tab

Select  "INSIDE DIA. MEASUREMENT-WORK ROTATION (PROBE Z)" on the [MEASURE] tab of the measurement cycle menu screen. The measurement operation setting screen appears.

- INNER

Enter the correct inside diameter of a circle by specifying a numeric value.

The other input items are the same as for "OUTSIDE DIAMETER MEASUREMENT-WORK ROTATION."

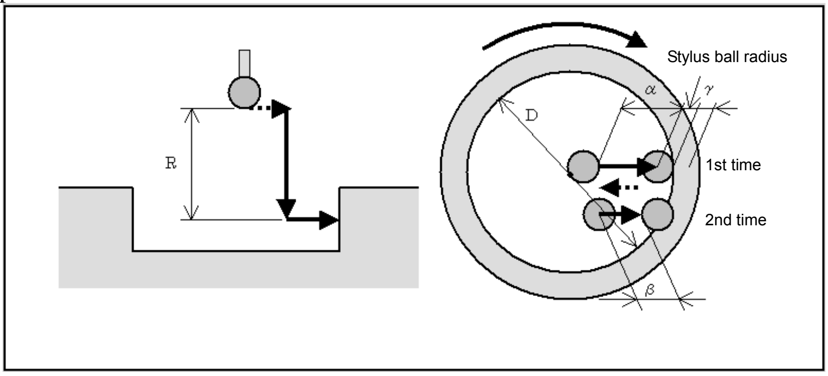
Input screen for automatic tool offset setting

The contents are the same as for "OUTSIDE DIA. MEASUREMENT-WORK ROTATION (PROBE Z)."

Measurement motion

- When rotation axis positioning based on C-axis rotation is used

A measurement operation with the +X direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified by “STARTING ANGLE.”
<2> A rapid movement is made from the current position to the point specified by ("CENTER POINT X"+("INNER"/2-α-r)) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<3> A rapid movement is made in the Z-axis direction to the approach point (“HEIGHT OF MEAS.PT.”+”APROCH DISTANCE”).
<4> A movement is made in the -Z-axis direction to the position specified by “HEIGHT OF MEAS.PT.” at feedrate fb.
<5> A measurement is made in the range (α + γ) at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to (β + γ). (Second measurement)
<7> A rapid return movement is made to the approach point in the X-axis direction.
<8> The C-axis is rotated by the angle specified by “PITCH ANGLE.”
<9> Steps <5> through <8> above are repeated as many times as specified by “MEASUREMENT POINT.”
<10>Finally, a rapid return movement is made to the approach point along the Z-axis.

> **NOTE**
> Specify a measurement direction in parameter No. 27231.

Meaning	Symbol in the explanation
Feed-rate for approaching start point (in the axis direction)	fb
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Escaping distance for 2nd measurement	ε
Stylus ball diameter/2	r

NOTE
The values of α, β, γ, ε, fb, f are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

- **When rotation axis positioning based on the spindle orientation function is used**

The measurement operation is the same as for "OUTSIDE DIA. MEASUREMENT-WORK ROTATION (PROBE Z)."

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2054 Q_ D_ H_ V_ L_ R_ N_ M_ F_ P_

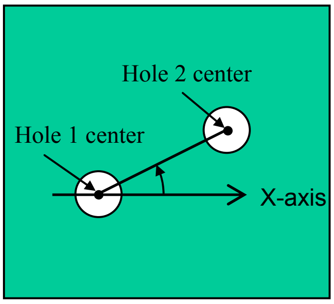
Measurement result

When G2054 is executed, the diameter of the circle is found from the average of the measurement results of individual measurement points then the offset value obtained from the differential from the target value (input item "INNER") is output to the specified tool offset item and macro variable for the result of measurement.

2.6 SIMPLE MEASUREMENT (PROBE Z-AXIS DIRECTION)

2.6.1 Measuring Angle of Line by 2 Holes (SIMPLE MEASUREMENT) (for Series 30*i*/31*i*/32*i*-B, 0*i*-F/0*i*-D)

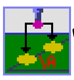
Angle of X-axis and line by center of 2 holes can be measured.
Measurement results are set into macro variable automatically.



2.6.1.1 Parameter setting for use of cycle

Set parameter No.27221#6=1.

2.6.1.2 Method of creating cycle

Select  "ANGLE OF LINE BY 2 HOLES(PROBE Z)" on the [SIMPLE] tab of the measurement cycle menu screen. The window for creating cycle is appears. Input the following item according to guidance drawing.

(1) [MOTION]tab

Input item		Meaning
Q	MEASUREMENT COND.	Measurement condition (centering measurement condition group number)
D	HOLE DIA.	Diameter of hole 1 and hole 2
L	HEIGHT OF MEAS.PT.	Height of a measurement position in the Z-axis direction
R	APROCH DISTANCE	Move distance from the approach point to a measurement position in the Z-axis direction
F	MOVING MEAS.SPEED	Feedrate for measurement
P	MEASUREMENT POINT	Number of measurement points (3 to 4)
M	SPINDLE ORIENTATION	Enable or disable of "spindle orientation" of each measurement point

(2) [MEAS. POS.]tab

Input item		Meaning
H	CENTER OF HOLE1(X)	X of the center position of hole 1
V	CENTER OF HOLE1(Y)	Y of the center position of hole 1
X	CENTER OF HOLE2(X)	X of the center position of hole 2
Y	CENTER OF HOLE2(Y)	Y of the center position of hole 2

(3) [VARIABLE M] / [VARIABLE T]tab

Input item		Meaning
W	SETTING MACRO VAR.	Macro variable number for storing the result of measurement. Setting value of the parameter No.27264 is default value.
A	ANGLE OF LINE	Target value of angle of X-axis and line by center hole 1 and hole 2
K	OK RANGE(±)	Specify an allowable range of measurement errors. If the following difference is within OK range, the result of measurement is not set into macro variable. · Difference between angle from measurement and the target value of angle
E	FEED BACK RANGE(±)	Specify the feed back range of measurement errors. (Measurement errors are feedback range from OK range) The result of measurement is set into macro variable. (Measurement errors are greater than feedback range) Alarm is displayed.

(*1) [VARIABLE M] tab is displayed when CNC is for machining center.
(*2) [VARIABLE T] tab is displayed when CNC is for lathe.

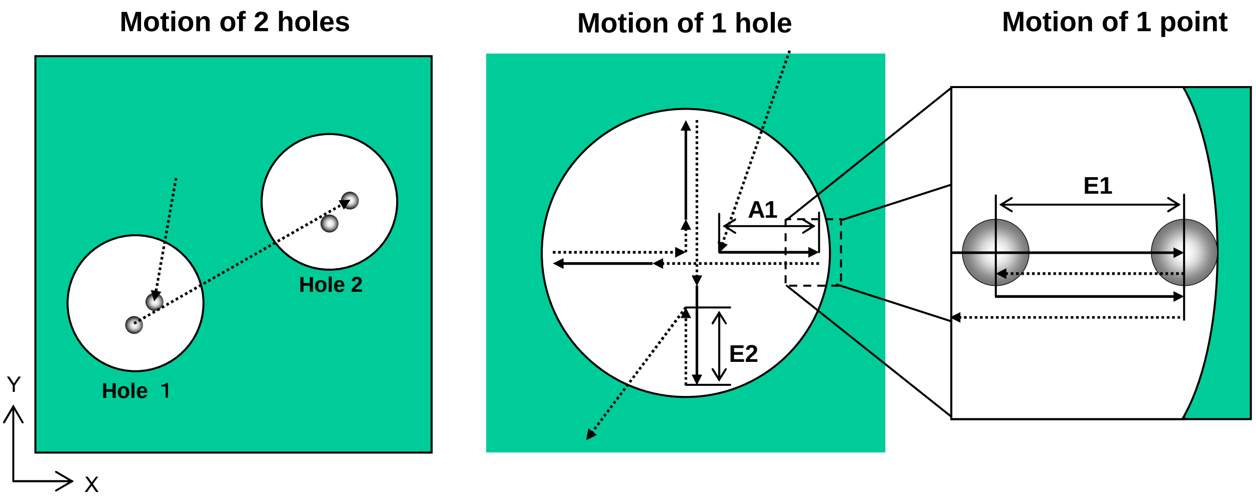
2.6.1.3 Program format

When INSERT key is pressed after entering necessary data in window for creating cycle, the following program is created.

```
G2362 Qq Dd Ll Rr Ff Pp Mm Hh Vv Xx Yy Ww Aa Kk Ee ;
```

2.6.1.4 Measurement motion

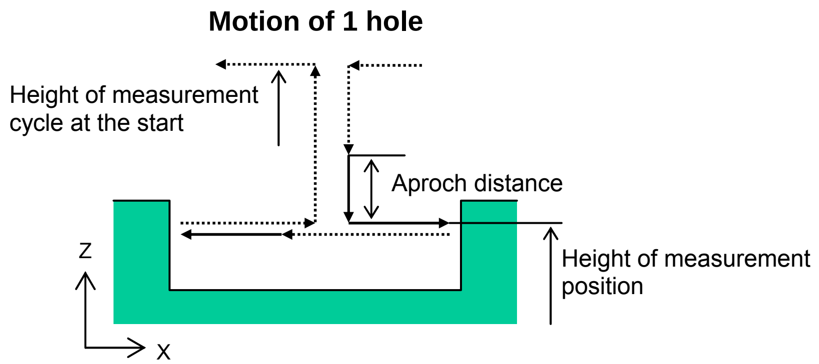
(XY-PLANE)



······▸ : Rapid movement
——▸ : G31

Data to be set in the measurement setting screens
A1 : Approach distance for 1st measurement
E1 : Escape distance for 1st measurement
E2 : Escape distance for 2nd measurement

(XZ-PLANE)

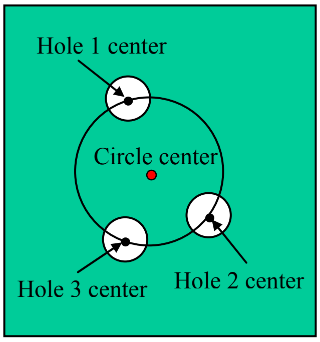


2.6.1.5 Measurement result

When G2362 is executed, measurement results are set into macro variable automatically.

2.6.2 Measuring Center of Circle by 3 Holes (SIMPLE MEASUREMENT) (for Series 30*i*/31*i*/32*i*-B, 0*i*-F/0*i*-D)

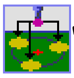
Center of circle by center of 3 holes can be measured.
Measurement results are set into macro variable automatically.



2.6.2.1 Parameter setting for use of cycle

Set parameter No.27221#6=1.

2.6.2.2 Method of creating cycle

Select  "CIRCLE BY 3 HOLES(PROBE Z)" on the [SIMPLE] tab of the measurement cycle menu screen. The window for creating cycle is appears. Input the following item according to guidance drawing.

(1) [MOTION]tab

Input item		Meaning
Q	MEASUREMENT COND.	Measurement condition (centering measurement condition group number)
D	HOLE DIA.	Diameter of hole 1, hole 2 and hole 3
L	HEIGHT OF MEAS.PT.	Height of a measurement position in the Z-axis direction
R	APROCH DISTANCE	Move distance from the approach point to a measurement position in the Z-axis direction
F	MOVING MEAS.SPEED	Feedrate for measurement
P	MEASUREMENT POINT	Number of measurement points (3 to 4)
M	SPINDLE ORIENTATION	Enable or disable of "spindle orientation" of each measurement point

(2) [MEAS. POS.]tab

Input item		Meaning
H	CENTER OF HOLE1(X)	X of the center position of hole 1
V	CENTER OF HOLE1(Y)	Y of the center position of hole 1
X	CENTER OF HOLE2(X)	X of the center position of hole 2
Y	CENTER OF HOLE2(Y)	Y of the center position of hole 2
W	CENTER OF HOLE3(X)	X of the center position of hole 3
Z	CENTER OF HOLE3(Y)	Y of the center position of hole 3

(3) [VARIABLE M] / [VARIABLE T]tab

Input item		Meaning
T	SETTING MACRO VAR.	Macro variable number for storing the result of measurement. Setting value of the parameter No.27265 is default value.
I	CENTER OF CIRCLE(X)	Target value of center position of circle by center hole 1, hole 2 and hole 3 (X coordinate value)

Input item		Meaning
J	CENTER OF CIRCLE(Y)	Target value of center position of circle by center hole 1, hole 2 and hole 3 (Y coordinate value)
K	OK RANGE(±)	Specify an allowable range of measurement errors. If the following difference is within OK range, the result of measurement is not set into macro variable. · Difference between center position of the circle from measurement and the target value of center position of the circle
E	FEED BACK RANGE(±)	Specify the feed back range of measurement errors. (Measurement errors are feedback range from OK range) The result of measurement is set into macro variable. (Measurement errors are greater than feedback range) Alarm is displayed.

(*1) [VARIABLE M] tab is displayed when CNC is for machining center.
(*2) [VARIABLE T] tab is displayed when CNC is for lathe.

2.6.2.3 Program format

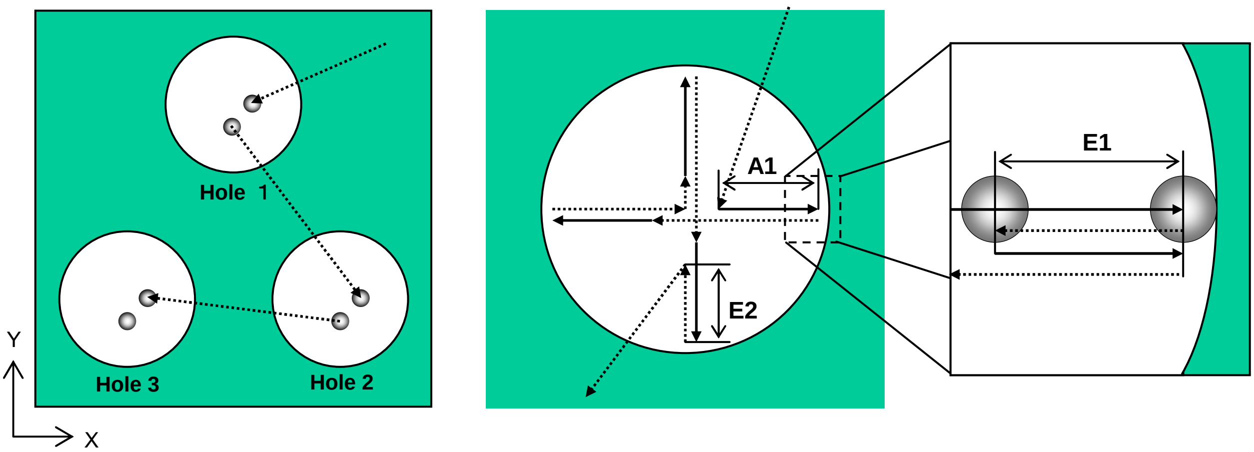
When INSERT key is pressed after entering necessary data in window for creating cycle, the following program is created.

G2360 Qq Dd Ll Rr Ff Pp Mm Hh Vv Xx Yy Ww Zz Tt Ii Jj Kk Ee;

2.6.2.4 Measurement motion

(XY-PLANE)

Motion of 3 holes **Motion of 1 hole** **Motion of 1 point**

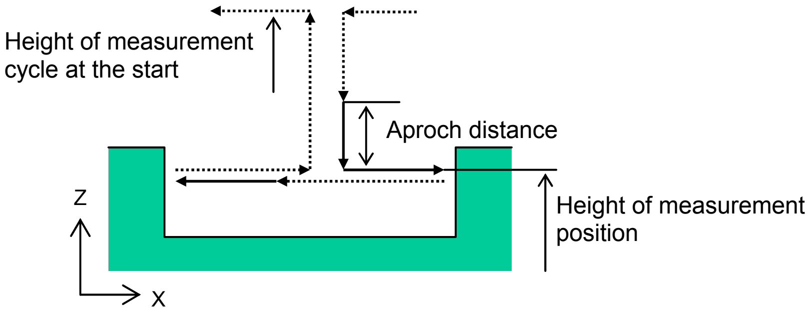


: Rapid movement
: G31

Data to be set in the measurement setting screens
A1 : Approach distance for 1st measurement
E1 : Escape distance for 1st measurement
E2 : Escape distance for 2nd measurement

(XZ-PLANE)

Motion of 1 hole



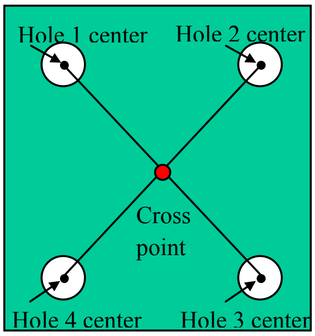
2.6.2.5 Measurement result

When G2360 is executed, measurement results are set into the following macro variable automatically.

(1) #[T(SETTING MACRO VAR.)+0] = Center position of circle by center of 3 holes (X coordinate value)
(2) #[T(SETTING MACRO VAR.)+1] = Center position of circle by center of 3 holes (Y coordinate value)
(3) #[T(SETTING MACRO VAR.)+2] = Diameter of circle by center of 3 holes

2.6.3 Measuring Cross of Diagonal by 4 Holes (SIMPLE MEASUREMENT) (for Series 30*i*/31*i*/32*i*-B, 0*i*-F/0*i*-D)

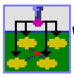
Cross point of diagonal by center of 4 holes can be measured.
Measurement results are set into macro variable automatically.



2.6.3.1 Parameter setting for use of cycle

Set parameter No.27221#6=1.

2.6.3.2 Method of creating cycle

Select  "DIAGONAL BY 4 HOLES(PROBE Z)" on the [SIMPLE] tab of the measurement cycle menu screen. The window for creating cycle is appears. Input the following item according to guidance drawing.

(1) [MOTION]tab

Input item		Meaning
Q	MEASUREMENT COND.	Measurement condition (centering measurement condition group number)
D	HOLE DIA.	Diameter of hole 1, hole 2, hole 3 and hole 4
L	HEIGHT OF MEAS.PT.	Height of a measurement position in the Z-axis direction
R	APROCH DISTANCE	Move distance from the approach point to a measurement position in the Z-axis direction
F	MOVING MEAS.SPEED	Feedrate for measurement
P	MEASUREMENT POINT	Number of measurement points (3 to 4)
M	SPINDLE ORIENTATION	Enable or disable of "spindle orientation" of each measurement point

(2) [MEAS. POS.]tab

Input item		Meaning
H	CENTER OF HOLE1(X)	X of the center position of hole 1
V	CENTER OF HOLE1(Y)	Y of the center position of hole 1
X	CENTER OF HOLE2(X)	X of the center position of hole 2
Y	CENTER OF HOLE2(Y)	Y of the center position of hole 2
W	CENTER OF HOLE3(X)	X of the center position of hole 3
Z	CENTER OF HOLE3(Y)	Y of the center position of hole 3
C	CENTER OF HOLE4(X)	X of the center position of hole 4
S	CENTER OF HOLE4(Y)	Y of the center position of hole 4

(3) [VARIABLE M] / [VARIABLE T]tab

Input item		Meaning
T	SETTING MACRO VAR.	Macro variable number for storing the result of measurement. Setting value of the parameter No.27266 is default value.
I	CROSS OF DIAG.(X)	Target value of cross of diagonal by center hole 1 from hole 3 and diagonal by center hole 2 from hole 4 (X coordinate value)
J	CROSS OF DIAG.(Y)	Target value of cross of diagonal by center hole 1 from hole 3 and diagonal by center hole 2 from hole 4 (Y coordinate value)
K	OK RANGE(±)	Specify an allowable range of measurement errors. If the following difference is within OK range, the result of measurement is not set into macro variable. · Difference between cross position of diagonal from measurement and the target value of cross position of diagonal.
E	FEED BACK RANGE(±)	Specify the feed back range of measurement errors. (Measurement errors are feedback range from OK range) The result of measurement is set into macro variable. (Measurement errors are greater than feedback range) Alarm is displayed.

(*1) [VARIABLE M] tab is displayed when CNC is for machining center.
(*2) [VARIABLE T] tab is displayed when CNC is for lathe.

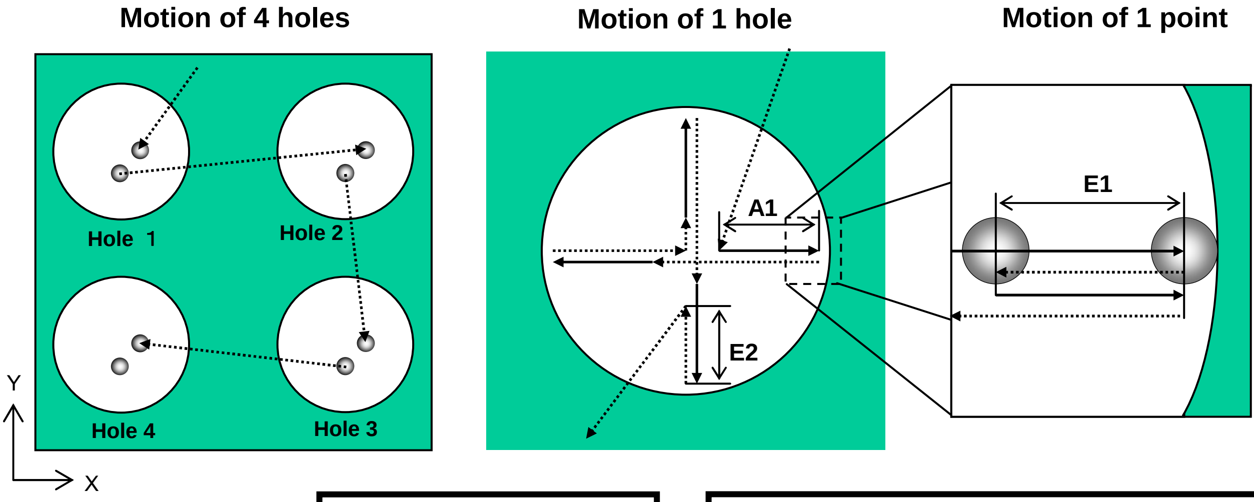
2.6.3.3 Program format

When INSERT key is pressed after entering necessary data in window for creating cycle, the following program is created.

G2361 Qq Dd Ll Rr Ff Pp Mm Hh Vv Xx Yy Ww Zz Cc Ss Tt Ii Jj Kk Ee;

2.6.3.4 Measurement motion

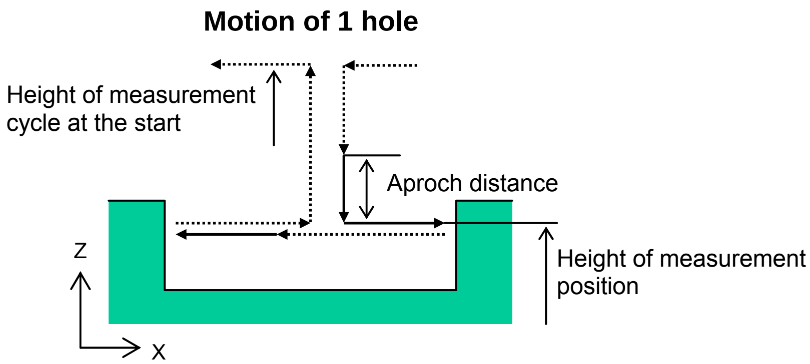
(XY-PLANE)



- ········▸ : Rapid movement
- ———▸ : G31

Data to be set in the measurement setting screens
A1 : Approach distance for 1st measurement
E1 : Escape distance for 1st measurement
E2 : Escape distance for 2nd measurement

(XZ-PLANE)



2.6.3.5 Measurement result

When G2361 is executed, measurement results are set into the following macro variable automatically.

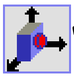
(1) #[T(SETTING MACRO VAR.)+0] = Cross point of diagonal by center of 4 holes (X coordinate value)

(2) #[T(SETTING MACRO VAR.)+1] = Cross point of diagonal by center of 4 holes (Y coordinate value)

2.7 CALIBRATION (PROBE X-AXIS DIRECTION)

2.7.1 Touch Sensor Position Measurement

When the reference tool is oriented in the X-axis direction, the position of the touch sensor for tool measurement is measured.

Select "TOUCH SENSOR POSITION MEASUREMENT(TOOL X-AXIS)"on the [CALIBRATE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

The displayed items are the same as for "TOUCH SENSOR POSITION MEASUREMENT (TOOL Z-AXIS)".

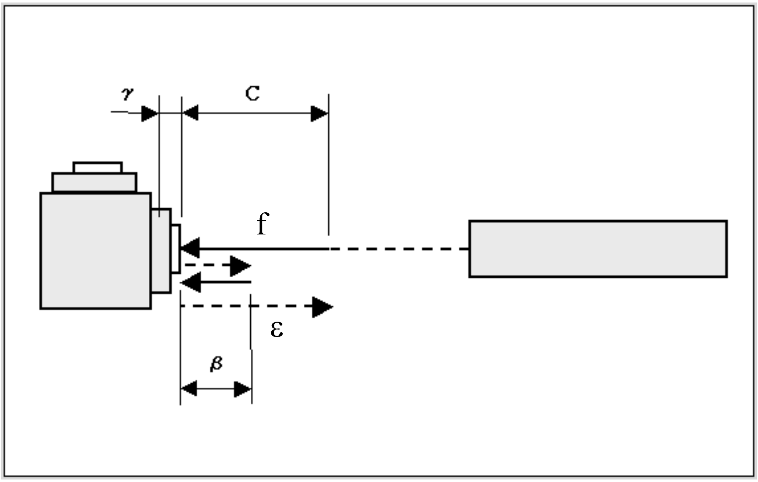
[SETTING] tab

The displayed items are the same as for "TOUCH SENSOR POSITION MEASUREMENT (TOOL Z-AXIS)".

Measurement motion

Measurement motion is described below.

- Measurement of the touch sensor position for measurement in the -X-axis direction



<1> A rapid movement is made from the current position to the approach point (Y coordinate,Z coordinate).
Here, the approach point (Y coordinate,Z coordinate) represents the touch sensor position (Ay,Az).
<2> In the -X -axis direction, a rapid movement is made to the approach point (X coordinate).
Here, the approach point (X coordinate) represents (touch sensor position Ax + "CLEARANCE").
<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)
<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)
<5> Then, a rapid return movement is made by ε in the +X-axis direction.

The symbols used above have the following meanings:

A: Touch sensor position. If "SETTIN" is selected in "SPECIFY OF MEAS. PT.", A represents the "sensor position for measurement in -X direction" of the specified condition. If "INPUT" is specified in "SPECIFY OF MEAS. PT.", A represents the coordinates specified by "MEASURE POINT X", "MEASURE POINT Y", and "MEASURE POINT Z".

Ax: X coordinate of the touch sensor position above

Ay: Y coordinate of the touch sensor position above

Az: Z coordinate of the touch sensor position above

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."

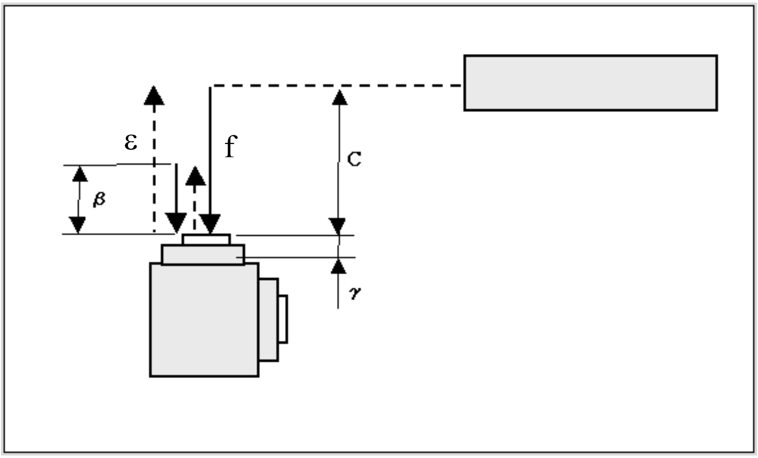
f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

- Measurement of the touch sensor position for measurement in the -Y-axis direction



<1> A rapid movement is made from the current position to the approach point (Y coordinate,Z coordinate).
Here, the approach point (Y coordinate) represents (touch sensor position Ay + "CLEARANCE"). The approach point (Z coordinate) represents the touch sensor position Az.

<2> In the X-axis direction, a rapid movement is made to the approach point (X coordinate).
The approach point (X coordinate) represents the touch sensor position Ax.

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

<5> Then, a rapid return movement is made by ε in the +Y-axis direction.

- Measurement of the touch sensor position for measurement in the +Y-axis direction

<1> A rapid movement is made from the current position to the approach point (Y coordinate,Z coordinate).
Here, the approach point (Y coordinate) represents (touch sensor position Ay - "CLEARANCE"). The approach point (Z coordinate) represents the touch sensor position Az.

<2> In the X-axis direction, a rapid movement is made to the approach point (X coordinate).
The approach point (X coordinate) represents the touch sensor position Ax.

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)
<5> Then, a rapid return movement is made by ε in the -Y-axis direction.

- Measurement of the touch sensor position for measurement in the +Z-axis direction

<1> A rapid movement is made from the current position to the approach point (Y coordinate,Z coordinate).
Here, the approach point (Y coordinate) represents the touch sensor position Ay. The approach point (Z coordinate) represents (touch sensor position Az - "CLEARANCE").
<2> In the X-axis direction, a rapid movement is made to the approach point (X coordinate).
The approach point (X coordinate) represents the touch sensor position Ax.
<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)
<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)
<5> Then, a rapid return movement is made by ε in the -Z-axis direction.

- Measurement of the touch sensor position for measurement in the -Z-axis direction

<1> A rapid movement is made from the current position to the approach point (Y coordinate,Z coordinate).
Here, the approach point (Y coordinate) represents the touch sensor position Ay. The approach point (Z coordinate) represents (touch sensor position Az + "CLEARANCE").
<2> In the X-axis direction, a rapid movement is made to the approach point (X coordinate).
The approach point (X coordinate) represents the touch sensor position Ax.
<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)
<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)
<5> Then, a rapid return movement is made by ε in the +Z-axis direction.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

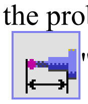
G2100 P_ Q_ B_ R_ K_ H_ V_ L_ C_ F_ W_ I_ S_ Y_ ;

Measurement result

When G2100 is executed, the result of measurement is output to macro variables for the result of measurement and as the touch sensor position of the calibration data in the specified measurement condition.

2.7.2 Probe Length Measurement

When the probe is oriented in the X-axis direction, the length of the probe is measured.

Select  "PROBE LENGTH CALIBRATION(PROBE X-AXIS)" on the [CALIBRATE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASURE POINT Y, Z

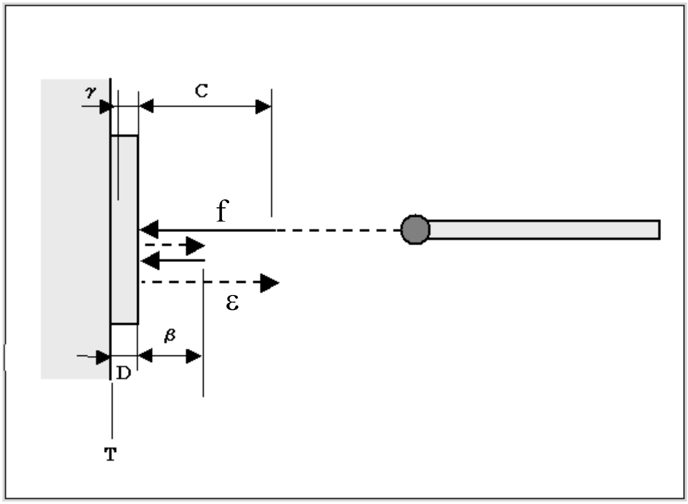
Enter the Y and Z coordinates of a measurement position by specifying numeric values.
The descriptions of the input items are the same as for "PROBE LENGTH CALIBRATION (PROBE Z-AXIS)".

[SETTING] tab

The displayed items are the same as for "Probe Length Measurement" of "CALIBRATION (PROBE Z-AXIS DIRECTION)".

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by "MEASURE POINT Y" and "MEASURE POINT Z".
<2> In the X-axis direction, a rapid movement is made to the approach point (X coordinate).
Here, the approach point (X coordinate) represents (T + "REFER. WORK HEIGHT" + "CLEARANCE").
<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)
<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the feedrate F specified by "MOVING MEAS.SPEED". (Second measurement)
<5> Then, a rapid return movement is made by ε in the +X-axis direction.

The symbols used above have the following meanings:
T: Height of the surface on which the reference workpiece is placed. ("HEIGHT OF PLANE PUT REFERENCE WORK (X)" on the measurement condition screen is referenced.)
f: Value of the "FEED-RATE FOR 1ST MEASUREMENT"" in the measurement condition of the group number specified in "MEASUREMENT COND."
β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

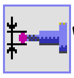
G2101 Q_ D_ H_ V_ C_ F_ S_ Y_ ;

Measurement result

When G2101 is executed, the measured value is output to macro variables for the result of measurement and as the probe length in the calibration data of the specified measurement condition.

2.7.3 Stylus Ball Diameter Measurement

The diameters of the stylus ball in the Y-axis direction and Z-axis direction are measured.

Select "STYLUS BALL DIAMETER CALIBRATION(PROBE X-AXIS)" on the [CALIBRATE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- APROCH CENTER PT. Y, Z

Enter the Y and Z coordinates of a measurement start position by specifying numeric values.
Usually, enter the coordinates of the center of the reference workpiece.

- HEIGHT OF MEAS. PT.

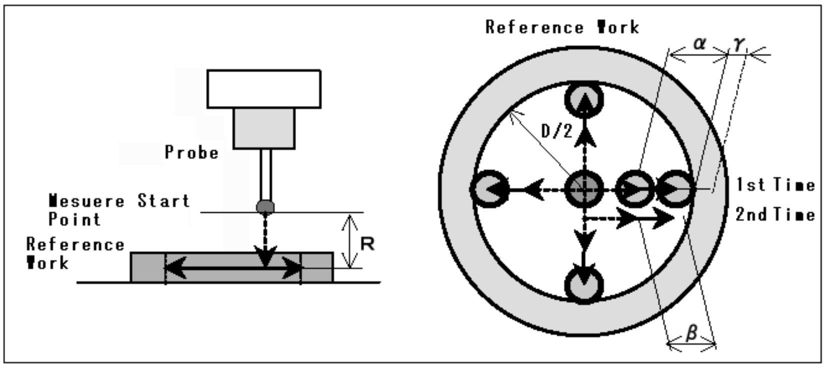
Enter the height of a measurement position in the X-axis direction by specifying a numeric value.
The descriptions of the other input items are the same as for "Stylus Ball Diameter Measurement" of "CALIBRATION (PROBE Z-AXIS DIRECTION)".

[SETTING] tab

The displayed items are the same as for "Stylus Ball Diameter Measurement" of "CALIBRATION (PROBE Z-AXIS DIRECTION)".

Measurement motion

Measurement motion is described below.



<1> The reference workpiece is placed on the table, then this measurement cycle is executed.
<2> When this measurement cycle is executed, a rapid movement is first made from the current position to the point specified by ("APROCH CENTER PT.Y" + ("BASE WORK RADIUS D"/2 - α - stylus radius r)) in the Y-axis direction and by "APROCH CENTER PT.Z" in the Z-axis direction.
<3> A rapid movement is made in the -X-axis direction to the point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<4> A movement is made in the -X-axis direction to a point of "HEIGHT OF MEAS. PT." at feedrate fb.
<5> In the range (α + γ), a movement is made in the +Y-axis direction at feedrate f. (First measurement)
<6> After a rapid return movement is made by β, a rapid movement is made to the Y coordinate specified by "APROCH CENTER PT.Y", then a movement is made at feedrate fa in the -Y-axis direction by the distance ("BASE WORK RADIUS D"/2 - α - stylus radius r).
<7> A similar measurement is made in the -Y-axis direction and ±Z-axis directions.

<8> After the first measurement, a center position for the second measurement is calculated from the measurement result of each point.
<9> In the +Y-axis direction, a movement is made at feedrate fa to the position (measurement position of the first measurement - β), then a measurement is made at the input feedrate MOVING MEAS. SPEED in the range from that position to ($\beta + \gamma$). (Second measurement)
<10>A similar measurement is made in the -Y-axis direction and ±Z-axis directions.
<11>A return movement is made by "APROCH DISTANCE" in the X-axis direction.

When bit 3 (SHRT) of parameter No. 12380 = 1
<1> The reference workpiece is placed on the table, then this measurement cycle is executed.
<2> When this measurement cycle is executed, a rapid movement is first made from the current position to the point specified by ("APROCH CENTER PT.Y" + ("BASE WORK RADIUS D"/2 - α - stylus radius r)) in the Y-axis direction and by "APROCH CENTER PT.Z" in the Z-axis direction.
<3> A rapid movement is made in the -X-axis direction to the point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<4> A movement is made in the -X-axis direction to a point of "HEIGHT OF MEAS. PT." at feedrate fb.
<5> In the range ($\alpha + \gamma$), a movement is made in the +Y-axis direction at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to ($\beta + \gamma$). (Second measurement)
<7> After a rapid return movement is made by ε, a rapid movement is made to the Y coordinate specified by "APROCH CENTER PT.Y", then a movement is made at feedrate fa in the -Y-axis direction by the distance ("BASE WORK RADIUS D"/2 - α - stylus radius r).
<8> A similar measurement is made in the -Y-axis direction and ±Z-axis directions.
<9> A return movement is made by "APROCH DISTANCE" in the X-axis direction.

The symbols used above have the following meanings:
fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.
fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."
f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
α: Value of "APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

Motion depending on the number of measurement points

When "MEASUREMENT POINT" is set to 1, a measurement is made in the +Y-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +Y-axis and –Y-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +Y-axis, -Y-axis, and +Z-axis directions.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

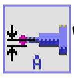
G2102 Q_ D_ H_ V_ L_ R_ F_ S_ Y_ ;

Measurement result

When G2102 is executed, the diameters of the stylus ball in the Y-axis and Z-axis directions are found from the measured values and are output to the calibration data and macro variables for the result of measurement.

2.7.4 Stylus Ball Center Offset Measurement-A

The offset between the center of the stylus ball and the center of the spindle is measured.

Select  "STYLUS OFFSETS CALIBRATION-A(PROBE X-AXIS)" on the [CALIBRATE] tab of the measurement cycle menu screen. The input screen appears.

> **NOTE**
> By using a function such as the spindle orientation function, the machine tool builder needs to make a preparation beforehand to enable the spindle to be positioned at 0° and 180° with a miscellaneous function (M code).

[MOTION] tab

- APROCH CENTER PT. Y, Z

Enter the Y and Z coordinates of a measurement start position by specifying numeric values.
Usually, enter the coordinates of the center of the reference workpiece.

- HEIGHT OF MEAS. PT.

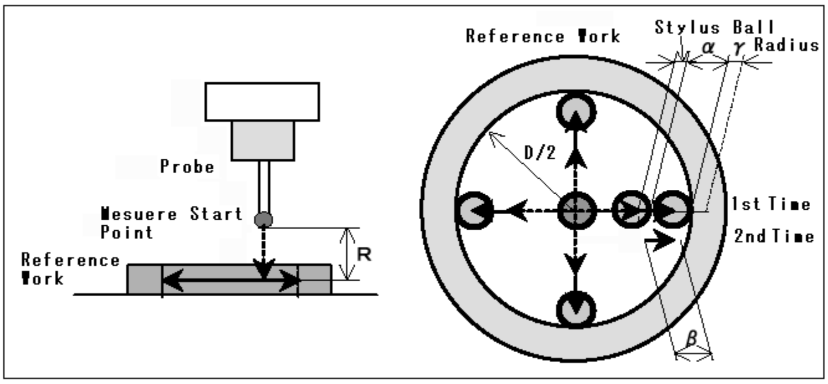
Enter the height of a measurement position in the X-axis direction by specifying a numeric value.
The descriptions of the other input items are the same as for "Stylus Ball Center Offset Measurement-A" of "CALIBRATION (PROBE Z-AXIS DIRECTION)".

[SETTING] tab

The displayed items are the same as for "Stylus Ball Center Offset Measurement-A" of "CALIBRATION (PROBE Z-AXIS DIRECTION)".

Measurement motion

Measurement motion is described below.



<1> The reference workpiece is placed on the table, then this measurement cycle is executed.
<2> When this measurement cycle is executed, a rapid movement is first made from the current position to the point specified by ("APROCH CENTER PT.Y" + ("BASE WORK RADIUS D"/2 - α - stylus radius r)) in the Y-axis direction and by "APROCH CENTER PT.Z" in the Z-axis direction.
<3> A rapid movement is made in the -X-axis direction to the point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<4> A movement is made in the -X-axis direction to a point of "HEIGHT OF MEAS. PT." at feedrate fb.
<5> After 0-degree spindle orientation is executed, a measurement is made in the +Y-axis direction in the range ($\alpha + \gamma$) at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to ($\beta + \gamma$). (Second measurement)
<7> Next, a rapid return movement is made by β, and 180-degree spindle orientation is executed, then a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to ($\beta + \gamma$). (Second measurement)
<8> After a rapid return movement is made by ε, a rapid movement is made to the Y coordinate specified by "APROCH CENTER PT.Y", then a movement is made at feedrate fa in the -Y-axis direction by the distance ("BASE WORK RADIUS D"/2 - α - stylus radius r).
<9> A similar measurement is made in the -Y-axis direction and ±Z-axis directions.
<10>A return movement is made by "APROCH DISTANCE" in the X-axis direction.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of "AAPPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

Motion depending on the number of measurement points

When "MEASUREMENT POINT" is set to 1, a measurement is made in the +Y-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +Y-axis and –Y-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +Y-axis, -Y-axis, and +Z-axis directions.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

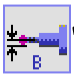
```
G2103 Q_ D_ H_ V_ L_ R_ F_ P_ S_ Y_ ;
```

Measurement result

When G2103 is executed, center offsets of the stylus ball in the Y-axis and Z-axis directions are found from the measured values and are output to the calibration data and macro variables for the result of measurement.

2.7.5 Stylus Ball Center Offset Measurement-B

The offset between the center of the stylus ball and the center of the spindle is measured.

Select  "STYLUS OFFSETS CALIBRATION-B(PROBE X-AXIS)" on the [CALIBRATE] tab of the measurement cycle menu screen. The input screen appears.

> **NOTE**
> The center of a reference workpiece needs to be placed accurately at a table position whose coordinates are known.

[MOTION] tab

- CENTER PT. Y

Enter the Y coordinate of the center of a reference workpiece by specifying a numeric value.

- CENTER PT. Z

Enter the Z coordinate of the center of a reference workpiece by specifying a numeric value.

- HEIGHT OF MEAS. PT.

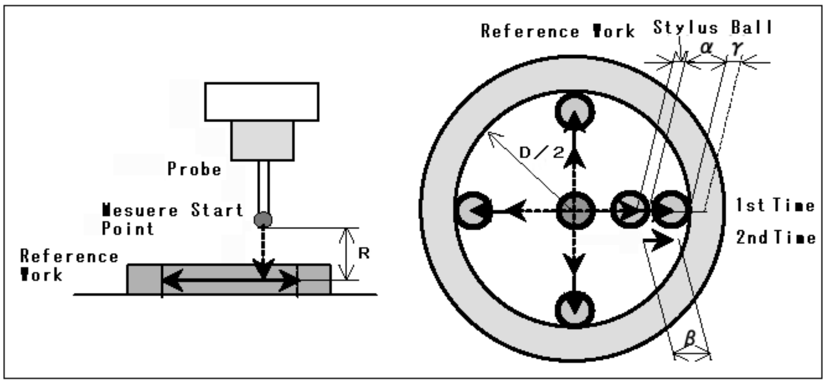
Enter the height of a measurement position in the X-axis direction by specifying a numeric value.
The descriptions of the other input items are the same as for "Stylus Ball Center Offset Measurement-B" of "CALIBRATION (PROBE Z-AXIS DIRECTION)".

[SETTING] tab

The displayed items are the same as for "Stylus Ball Center Offset Measurement-B" of "CALIBRATION (PROBE Z-AXIS DIRECTION)".

Measurement motion

Measurement motion is described below.



<1> The reference workpiece is placed on the table, then this measurement cycle is executed.

<2> When this measurement cycle is executed, a rapid movement is first made from the current position to the point specified by ("APROCH CENTER PT.Y" + ("BASE WORK RADIUS D"/2 - α - stylus radius r)) in the Y-axis direction and by "APROCH CENTER PT.Z" in the Z-axis direction.

<3> A rapid movement is made in the X-axis direction to the point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<4> A movement is made in the -X-axis direction to a point of "HEIGHT OF MEAS. PT." at feedrate fb.

<5> A measurement is made in the +Y-axis direction in the range (α + γ) at feedrate f. (First measurement)

<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)

<7> After a rapid return movement is made by ε, a rapid movement is made to the Y coordinate specified by "APROCH CENTER PT.Y", then a movement is made at feedrate fa in the -Y-axis direction by the distance ("BASE WORK RADIUS D"/2 - α - stylus radius r).
<8> A similar measurement is made in the -Y-axis direction and ±Z-axis directions.
<9> A return movement is made by "APROCH DISTANCE" in the X-axis direction.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of "APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

Motion depending on the number of measurement points

When "MEASUREMENT POINT" is set to 1, a measurement is made in the +Y-axis direction only.
When "MEASUREMENT POINT" is set to 2, a measurement is made in the +Y-axis and –Y-axis directions only.
When "MEASUREMENT POINT" is set to 3, a measurement is made in the +Y-axis, -Y-axis, and +Z-axis directions.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2104 Q_ D_ H_ V_ L_ R_ F_ P_ S_ Y_ ;
```

Measurement result

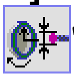
When G2104 is executed, center offsets of the stylus ball in the Y-axis and Z-axis directions are found from the input Y and Z center coordinates and the measured values and are output to the calibration data and macro variables for the result of measurement.

2.7.6 Stylus Ball Diameter Measurement (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the diameter of the stylus ball is obtained from the average of the results.

> **NOTE**
> This function is enabled when bit 1 (RST) of parameter No. 27222 is set to 1.

[MOTION] tab

Select  "STYLUS BALL DIA, CALIB.-WORK ROTATION (PROBE X)" on the [CALIBRATE] tab of the measurement cycle menu screen. The measurement operation setting screen appears.
The information displayed in each input item and operation are the same as for "STYLUS BALL DIA, CALIB.-WORK ROTATION (PROBE Z)."

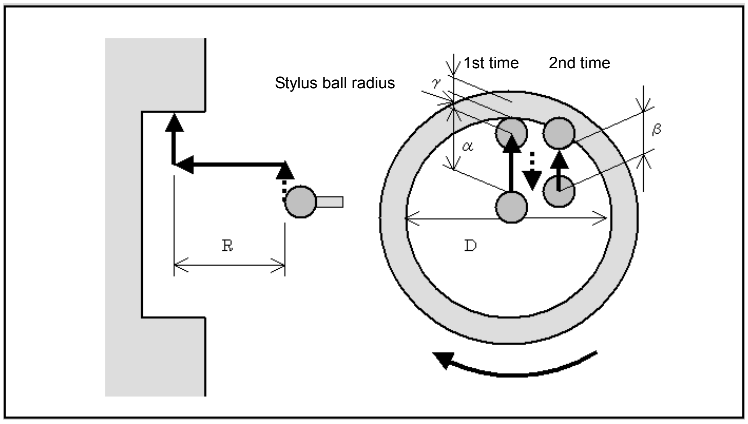
Input screen for automatic calibration data setting

This screen enables measurement values to be set as calibration data.
The information displayed in each input item and operation are the same as for “STYLUS BALL DIA, CALIB.-WORK ROTATION (PROBE Z).”

Measurement motion

- When rotation axis positioning based on C-axis rotation is used

A measurement operation with the +Z direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified by “STARTING ANGLE.”
<2> A rapid movement is made from the current position to the point specified by ("CENTER POINT Z"+("BASE WORK RADIUS"/2-α-r)) in the Z-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<3> A rapid movement is made in the X-axis direction to the approach point ("HEIGHT OF MEAS.PT."+"APROCH DISTANCE").
<4> A movement is made in the -X-axis direction to the position specified by "HEIGHT OF MEAS.PT." at feedrate fb.
<5> A measurement is made in the range ($\alpha + \gamma$) at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to ($\beta + \gamma$). (Second measurement)
<7> A rapid return movement is made in the Z-axis direction to the approach point.
<8> The C-axis is rotated by the angle specified by “PITCH ANGLE.”
<9> Steps <5> through <8> above are repeated as many times as specified by “MEASUREMENT POINT.”
<10>Finally, a rapid return movement is made to the approach point along the X-axis.

NOTE

Specify a measurement direction in parameter No. 27233.

Meaning	Symbol in the explanation
Feed-rate for approaching start point (in the axis direction)	fb
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β

Meaning	Symbol in the explanation
Overlap distance for measurement	γ
Escaping distance for 2nd measurement	ε
Stylus ball diameter/2	r

> **NOTE**
> The values of α, β, γ, ε, fb, f are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

- When rotation axis positioning based on the spindle orientation function is used

The measurement operation is the same as for "STYLUS BALL DIAMETER CALIBRATION (PROBE Z-AXIS)."

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2105 Q_ D_ H_ V_ L_ R_ N_ M_ F_ P_
```

Measurement result

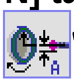
When G2105 is executed, the diameter of the stylus ball in the measurement direction is found from measured values and is output to the calibration data and macro variable for the result of measurement.

2.7.7 Stylus Ball Center Offset Measurement-A (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the center offset of the stylus ball is obtained from the average of the results.

> **NOTE**
> 1 This function is enabled when bit 1 (RST) of parameter No. 27222 is set to 1.
> 2 By using a function such as the spindle orientation function, the machine tool builder needs to position the spindle at 0° and 180° (probe axis) with a miscellaneous function (M code).

[MOTION] tab

Select  "STYLUS OFFSETS CALIB.-A-WORK ROTATION (PROBE X)"on the [CALIBRATE] tab of the measurement cycle menu screen. The measurement operation setting screen appears.
The information displayed in each input item and operation are the same as for "STYLUS BALL DIA, CALIB.-WORK ROTATION (PROBE X)."

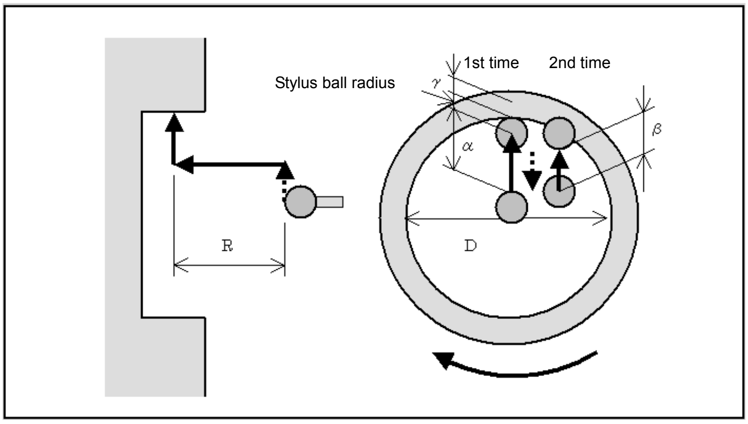
Input screen for automatic calibration data setting

This screen enables measurement values to be set as calibration data.
The information displayed in each input item and operation are the same as for “STYLUS BALL DIA, CALIB.-WORK ROTATION (PROBE X).”

Measurement motion

- When rotation axis positioning based on C-axis rotation is used

A measurement operation with the +Z direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified by “STARTING ANGLE.”

<2> A rapid movement is made from the current position to the point specified by ("CENTER POINT Z"+("BASE WORK RADIUS"/2-α-r)) in the Z-axis direction and by "CENTER POINT Y" in the Y-axis direction.

<3> A rapid movement is made in the X-axis direction to the approach point ("HEIGHT OF MEAS.PT."+"APROCH DISTANCE").

<4> A movement is made in the -X-axis direction to the position specified by “HEIGHT OF MEAS.PT.” at feedrate fb.

<5> After 0-degree spindle orientation is executed, a measurement is made in the range (α + γ) at feedrate f. (First measurement)

<6> Next, a rapid return movement is made by β then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to (β + γ). (Second measurement)

<7> A rapid return movement is further made by β, and 180-degree spindle orientation is executed, then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to (β + γ). (Third measurement)

<8> A rapid return movement is made in the Z-axis direction to the approach point.

<9> The C-axis is rotated by the angle specified by “PITCH ANGLE.”

<10>Steps <5> through <9> above are repeated as many times as specified by "MEASUREMENT POINT."

<11>Finally, a rapid return movement is made to the approach point along the X-axis.

> **NOTE**
> Specify a measurement direction in parameter No. 27233.

Meaning	Symbol in the explanation
Feed-rate for approaching start point (in the axis direction)	fb
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Escaping distance for 2nd measurement	ε
Stylus ball diameter/2	r

> **NOTE**
> The values of α, β, γ, ε, fb, f are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

- **When rotation axis positioning based on the spindle orientation function is used**

The measurement operation is the same as for "STYLUS BALL DIAMETER CALIBRATION (PROBE X-AXIS)."

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2106 Q_ D_ H_ V_ L_ R_ N_ M_ F_ P_

Measurement result

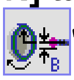
When G2106 is executed, the center offset of the stylus ball in the measurement direction is found from measured values and is output to the calibration data and macro variable for the result of measurement.

2.7.8 Stylus Ball Center Offset Measurement-B (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the center offset of the stylus ball is obtained from the average of the results.

> **NOTE**
> This function is enabled when bit 1 (RST) of parameter No. 27222 is set to 1.

[MOTION] tab

Select  "STYLUS OFFSETS CALIB.-B-WORK ROTATION (PROBE X)" on the [CALIBRATE] tab of the measurement cycle menu screen.The measurement operation setting screen appears.
The information displayed in each input item and operation are the same as for “STYLUS BALL DIA, CALIB.-WORK ROTATION (PROBE X).”

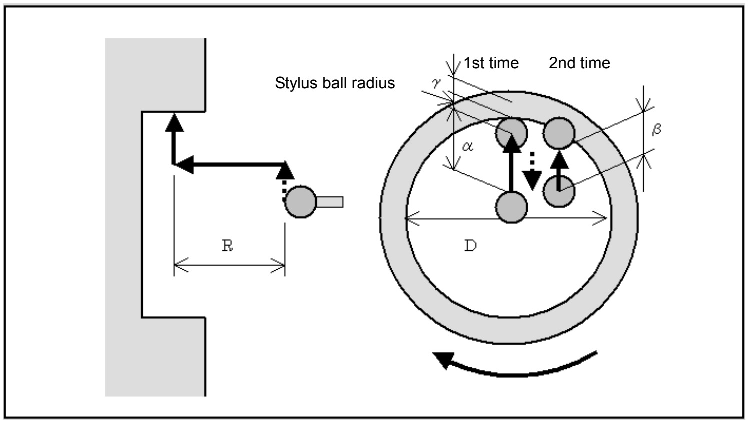
Input screen for automatic calibration data setting

This screen enables measurement values to be set as calibration data.
The information displayed in each input item and operation are the same as for "STYLUS OFFSETS CALIB.-A-WORK ROTATION (PROBE X)."

Measurement motion

- **When rotation axis positioning based on C-axis rotation is used**

A measurement operation with the +Z direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified by “STARTING ANGLE.”
<2> A rapid movement is made from the current position to the point specified by ("CENTER POINT Z"+("BASE WORK RADIUS"/2-α-r)) in the Z-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<3> A rapid movement is made in the X-axis direction to the approach point (“HEIGHT OF MEAS.PT.”+”APROCH DISTANCE”).
<4> A movement is made in the -X-axis direction to the position specified by “HEIGHT OF MEAS.PT.” at feedrate fb.
<5> A measurement is made in the range ($\alpha + \gamma$) at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to ($\beta + \gamma$). (Second measurement)
<7> A rapid return movement is made in the Z-axis direction to the approach point.
<8> The C-axis is rotated by the angle specified by “PITCH ANGLE.”
<9> Steps <5> through <8> above are repeated as many times as specified by “MEASUREMENT POINT.”
<10>Finally, a rapid return movement is made to the approach point along the X-axis.

NOTE
Specify a measurement direction in parameter No. 27233.

Meaning	Symbol in the explanation
Feed-rate for approaching start point (in the axis direction)	fb
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Escaping distance for 2nd measurement	ε
Stylus ball diameter/2	r

NOTE
The values of α, β, γ, ε, fb, f are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

- When rotation axis positioning based on the spindle orientation function is used

The measurement operation is the same as for "STYLUS OFFSETS CALIBRATION-B (PROBE Z-AXIS)."

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2107 Q_ D_ H_ V_ L_ R_ N_ M_ F_ P_

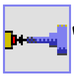
Measurement result

When G2107 is executed, the center offset of the stylus ball in the measurement direction is found from the input value of "CENTER PT." in the measurement direction and measured values and is output to the calibration data and macro variable for the result of measurement.

2.8 TOOL MEASUREMENT (TOOL X-AXIS DIRECTION)

2.8.1 Milling Tool Measurement

When the milling tool is oriented in the X-axis direction, the figure of the tool in the tool length direction and tool radius direction is measured.

Select  "MILLING TOOL MEASUREMENT(TOOL X-AXIS)"on the [TOOL MESUR] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

The displayed items are the same as for "Milling Tool Measurement" of "TOOL MESUREMENT (TOOL Z-AXIS DIRECTION)".

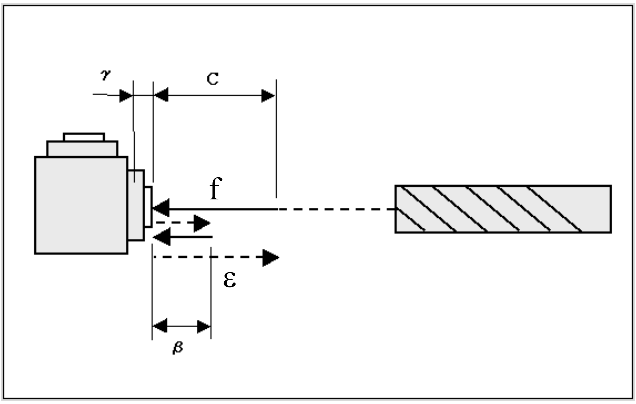
[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for "Milling Tool Measurement" of "TOOL MESUREMENT (TOOL Z-AXIS DIRECTION)."

Measurement motion

Measurement motion is described below.

- Measurement of an offset value in the -X-axis direction (measurement of an offset value in the tool length direction) - When [AUTO] is selected in "SPECIFY OF X, Y, and Z SHIFT"



The measurement motion described below is made when [AUTO] is selected in all input items of “SPECIFY OF X SHIFT”, “SPECIFY OF Y SHIFT”, and “SPECIFY OF Z SHIFT”.

<1> A rapid movement is made from the current position to the approach point (Y coordinate,Z coordinate).
Here, the approach point (Y coordinate,Z coordinate) represents the Y and Z coordinates of the "sensor position for measurement in the -X direction" of the touch sensor position in the specified measurement condition.

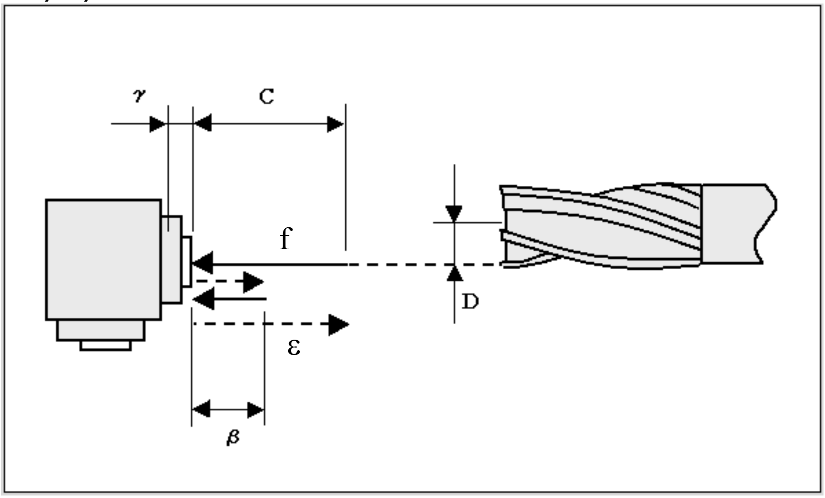
<2> In the -X-axis direction, a rapid movement is made to the approach point (X coordinate).
Here, the approach point (X coordinate) represents (the X coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position in the specified measurement condition + "CLEARANCE" + OFS_H).

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to ($\beta + \gamma$) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

<5> Then, a rapid return movement is made by ε in the +X-axis direction.

- Measurement of an offset value in the -X-axis direction (measurement of an offset value in the tool length direction) - When a soft key other than [AUTO] is selected in "SPECIFY OF X, Y, and Z SHIFT"



If the Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position is shifted from the Z coordinate of the tool measurement position as shown below, specify the shift amount in "SPECIFY OF Z SHIFT".

For example, the motion described below is made when [OFSET+] is selected in "SPECIFY OF Z SHIFT". (It is assumed that [AUTO] is selected for the X-axis direction and the Y-axis direction.)

<1> A rapid movement is made from the current position to the approach point (Y coordinate, Z coordinate).
Here, the approach point (Y coordinate) represents Y coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position in the specified measurement condition. The approach point (Z coordinate) represents the (Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position in the specified measurement condition + OFS_D).

<2> In the -X-axis direction, a rapid movement is made to the approach point (X coordinate).
Here, the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position in the specified measurement condition + "CLEARANCE" + OFS_H).

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

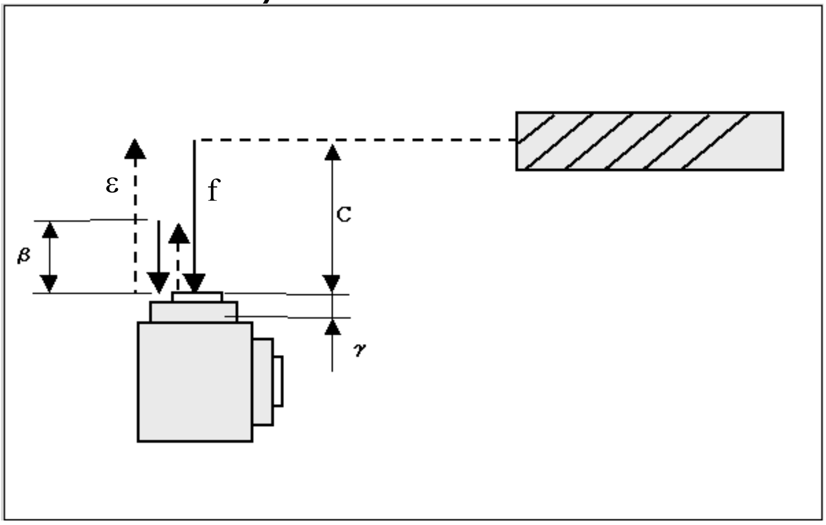
<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

<5> Then, a rapid return movement is made by ε in the +X-axis direction.

- If [OFSET-] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position - OFS_D).
- If [INPUT+] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position + the value entered in "OFFSET/DIFFERENCE Z"). If [INPUT-] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -X direction" - the value entered in "OFFSET/DIFFERENCE Z").
- If [DIFF+] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position + (OFS_D + the value entered in "OFFSET/DIFFERENCE Z")). If [DIFF-] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -X direction" - (OFS_D + the value entered in "OFFSET/DIFFERENCE Z")).

The descriptions above apply to the input in "SPECIFY OF X and Y SHIFT" and motion in the X-axis and Y-axis.

- Measurement of an offset value in the -Z-axis direction (measurement of an offset value in the tool radius direction)



The measurement motion described below is made when [AUTO] is selected in all input items of “SPECIFY OF X SHIFT”, “SPECIFY OF Y SHIFT”, and “SPECIFY OF Z SHIFT”.

<1> A rapid movement is made from the current position to the approach point (Y coordinate,Z coordinate).
Here, the approach point (Y coordinate) represents the Y coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position in the specified measurement condition. The approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position in the specified measurement condition + "CLEARANCE" + OFS_D).

<2> In the X-axis direction, a rapid movement is made to the approach point (X coordinate).
Here, the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position in the specified measurement condition + OFS_H).

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

<5> Then, a rapid return movement is made by ε in the +Z-axis direction.

If the coordinates of the "sensor position for measurement in the -Z direction" of the touch sensor position are shifted from the coordinates of the tool measurement position, specify the shift in "SPECIFY OF X, Y, or Z SHIFT".
For example, the motion described below is made when a soft key other than [AUTO] is selected in "SPECIFY OF X SHIFT".

- If [OFSET+] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position + OFS_H).
- If [INPUT+] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position + the value entered in "OFFSET/DIFFERENCE X").
- If [DIFF+] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -Z direction" of the touch sensor position + (OFS_H + the value entered in "OFFSET/DIFFERENCE X")).

The descriptions above apply to the input in "SPECIFY OF Y and Z SHIFT" and motion in the Y-axis and Z-axis.

- Measurement of an offset value in the +Z-axis direction (measurement of an offset value in the tool radius direction)

Same as for measurement in the -Z-axis direction

- Measurement of an offset value in the +Y-axis direction (measurement of an offset value in the tool radius direction)

Same as for measurement in the -Z-axis direction

- Measurement of an offset value in the -Y-axis direction (measurement of an offset value in the tool radius direction)

Same as for measurement in the -Z-axis direction

The symbols used above have the following meanings:

f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

OFS_H : Tool length direction offset value.

OHSD : Tool radius direction offset value.

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

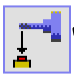
G2110 P_ Q_ C_ F_ H_ D_ V_ R_ L_ Z_ W_ I_ S_ Y_ U_ J_ K_ E_ ;

Measurement result

When G2110 is executed, the result of measurement is output to macro variables for the result of measurement and as a specified tool offset value.

2.8.2 Turning Tool Measurement

When the turning tool is oriented in the X-axis direction, the figure of the tool in the Z-axis direction and X-axis direction is measured.

Select  "TURNING TOOL MEASUREMENT(TOOL X-AXIS)" on the [TOOL MESUR] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT METH.

Select a measurement axis direction from the soft keys.

The other items are the same as for "Turning Tool Measurement" of "TOOL MEASUREMENT (TOOL Z-AXIS DIRECTION)".

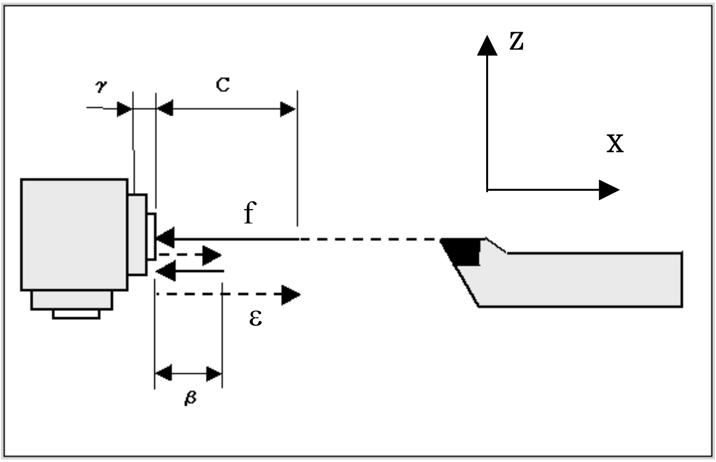
[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for "Turning Tool Measurement" of "TOOL MEASUREMENT (TOOL Z-AXIS DIRECTION)."

Measurement motion

Measurement motion is described below.

- Measurement of an offset value in the -X-axis direction



The measurement motion described below is made when [AUTO] is selected in all input items of “SPECIFY OF X SHIFT”, “SPECIFY OF Y SHIFT”, and “SPECIFY OF Z SHIFT”.

<1> A rapid movement is made from the current position to the approach point (Y coordinate,Z coordinate).
Here, the approach point (Y coordinate) represents Y coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position in the specified measurement condition. The approach point (Z coordinate) represents the (Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position in the specified measurement condition + OFS_Z).

<2> In the X -axis direction, a rapid movement is made to the approach point (X coordinate).
Here, the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position in the specified measurement condition + "CLEARANCE" + OFS_X).

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

<5> Then, a rapid return movement is made by ε in the +X-axis direction.

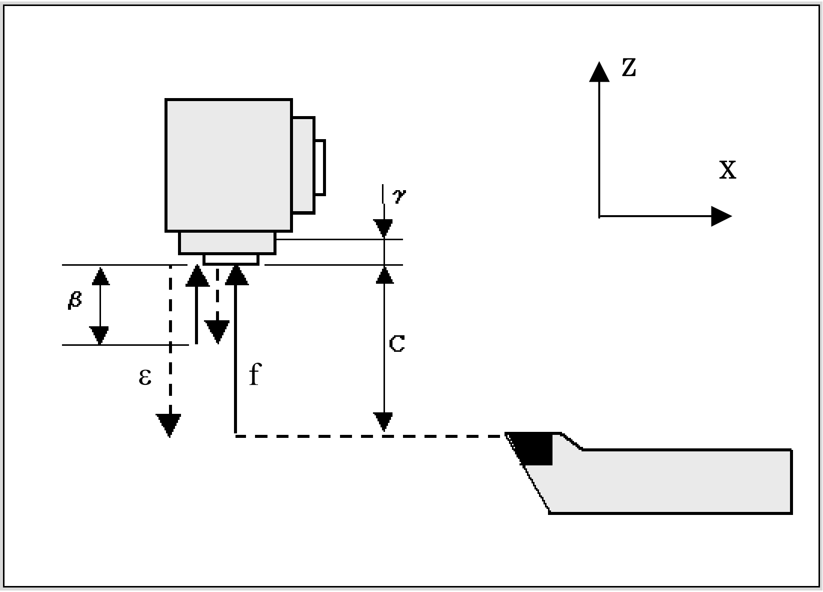
If the coordinates of the "sensor position for measurement in the -X direction" of the touch sensor position are shifted from the coordinates of the tool measurement position, specify the shift in "SPECIFY OF X, Y, or Z SHIFT".
For example, the motion described below is made when a soft key other than [AUTO] is selected in "SPECIFY OF Z SHIFT".

- If [OFFSET] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position + OFS_Z).
- If [INPUT] is selected in "SPECIFY OF Z SHIFT", the approach point (X coordinate) represents (Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position + the value entered in "OFFSET/DIFFERENCE Z").

- If [DIFFER] is selected in "SPECIFY OF Z SHIFT", the approach point (Z coordinate) represents (Z coordinate of the "sensor position for measurement in the -X direction" of the touch sensor position + (OFS_Z + the value entered in "OFFSET/DIFFERENCE Z")).

The descriptions above apply to the input in "SPECIFY OF X and Y SHIFT" and motion in the X-axis and Y-axis.

- Measurement of an offset value in the +Z-axis direction



The measurement motion described below is made when [AUTO] is selected in all input items of “SPECIFY OF X SHIFT”, “SPECIFY OF Y SHIFT”, and “SPECIFY OF Z SHIFT”.

<1> A rapid movement is made from the current position to the approach point (Y coordinate,Z coordinate).
Here, the approach point (Y coordinate) represents the Y coordinate of the "sensor position for measurement in the +Z direction" of the touch sensor position in the specified measurement condition. The approach point (Z coordinate) represents (the Z coordinate of the "sensor position for measurement in the +Z direction" of the touch sensor position in the specified measurement condition - "CLEARANCE" + OFS_Z).

<2> In the X-axis direction, a rapid movement is made to the approach point (X coordinate).
Here, the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the +Z direction" of the touch sensor position in the specified measurement condition + OFS_X).

<3> In the range from the approach point to ("CLEARANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

<5> Then, a rapid return movement is made by ε in the -Z-axis direction.

If the coordinates of the "sensor position for measurement in the +Z direction" of the touch sensor position are shifted from the coordinates of the tool measurement position, specify the shift in "SPECIFY OF X, Y, or Z SHIFT".
For example, the motion described below is made when a soft key other than [AUTO] is selected in "SPECIFY OF X SHIFT".

- If [OFFSET] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the +Z direction" of the touch sensor position + OFS_X).

- If [INPUT] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the +Z direction" of the touch sensor position + the value entered in "OFFSET/DIFFERENCE X").
- If [DIFFER] is selected in "SPECIFY OF X SHIFT", the approach point (X coordinate) represents (X coordinate of the "sensor position for measurement in the +Z direction" of the touch sensor position + (OFS_X + the value entered in "OFFSET/DIFFERENCE X")).

The descriptions above apply to the input in "SPECIFY OF Y and Z SHIFT" and motion in the Y-axis and Z-axis.

- Measurement of an offset value in the -Z-axis direction

Same as for measurement of an offset value in the +Z-axis direction

The symbols used above have the following meanings:

f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

OFS_X : X-axis direction offset value

OFS_Z : Z-axis direction offset value

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2111 P_ Q_ C_ F_ H_ D_ V_ R_ L_ Z_ W_ I_ S_ Y_ ;
```

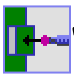
Measurement result

When G2111 is executed, the result of measurement is output to macro variables for the result of measurement and as a tool offset value.

2.9 WORK SET (PROBE X-AXIS DIRECTION)

2.9.1 End Face (X-axis Direction) Measurement

The position of an end face in the X-axis direction is measured.

Select "INSERT MEASUREMENT CYCLE" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

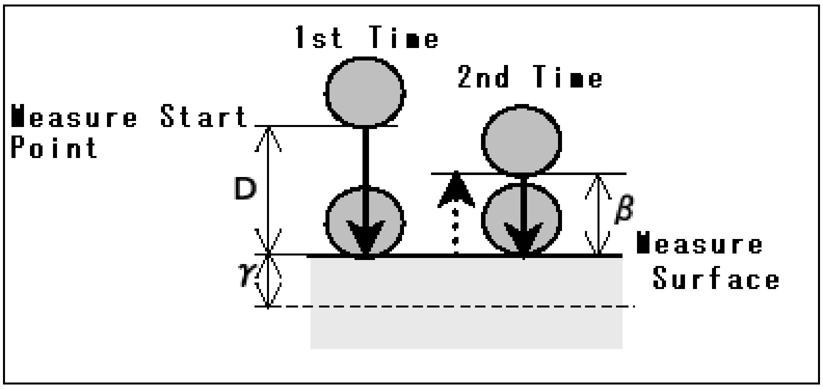
The displayed items are the same as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)" except that the screen title shows "X-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)".

[T-WORK] and [M-WORK] tabs

The input screens for automatic workpiece offset setting are the same as for "X-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)," except that the screen title is changed to "X-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)."

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the position specified by "MEASURE POINT Y" and "MEASURE POINT Z".

<2> In the X-axis direction, a rapid movement is made to the approach point (X coordinate).
Here, the approach point (X coordinate) represents ("MEASURE POINT X" - "APROCH DISTANCE") when the measurement direction is "+X", or the approach point (X coordinate) represents ("MEASURE POINT X" + "APROCH DISTANCE") when the measurement direction is "-X".

<3> In the range from the approach point to ("APROCH DISTANCE" + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

The symbols used above have the following meanings:

f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

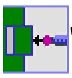
```
G2120 Q_ P_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2120 is executed, the result of measurement is output to macro variables for the result of measurement and as the X coordinate of a specified workpiece origin offset value.

2.9.2 End Face (Y-axis Direction) Measurement

The position of an end face in the Y-axis direction is measured.

Select  "Y-AXIS DIRECTION WORK SETUP(PROBE X-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

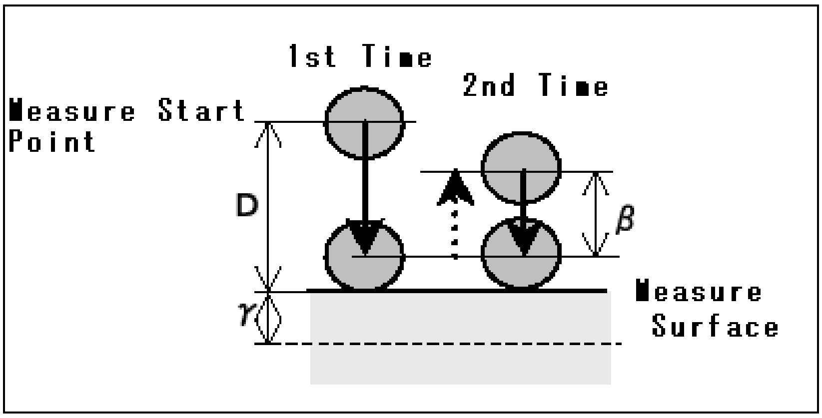
The displayed items are the same as for "Y-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)" except that the screen title shows "Y-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)".

[T-WORK] and [M-WORK] tabs

The input screens for automatic workpiece offset setting are the same as for "Y-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)," except that the screen title is changed to "Y-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)."

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the approach point (Y coordinate,Z coordinate).
Here, the approach point (Y coordinate) represents ("MEASURE POINT Y" - α) when the measurement direction is "+Y", or the approach point (Y coordinate) represents ("MEASURE POINT Y" + α) when the measurement direction is "-Y". The approach point (Z coordinate) is the same as "MEASURE POINT Z".

<2> In the X-axis direction, a rapid movement is made to the point ("MEASURE POINT X" + "APROCH DISTANCE").

<3> In the X-axis direction, a movement is made to "MEASURE POINT X" at feedrate fb.

<4> In the range from the approach point to (α + γ - stylus ball radius r), a measurement is made at feedrate f. (First measurement)

<5> Next, a rapid return movement is made by β, and a measurement is made in the range from that position to (β + γ) at the specified feedrate MOVING MEAS. SPEED. (Second measurement)

<6> Then, a return movement is made by "APROCH DISTANCE" in the X-axis direction.

The symbols used above have the following meanings:

f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

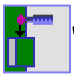
G2121 Q_ P_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;

Measurement result

When G2121 is executed, the result of measurement is output to macro variables for the result of measurement and as the Y coordinate of a specified workpiece origin offset value.

2.9.3 End Face (Z-axis Direction) Measurement

The position of an end face in the Z-axis direction is measured.

Select  "Z-AXIS DIRECTION WORK SETUP(PROBE X-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

The displayed items are the same as for "Z-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)" except that the screen title shows "Z-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)".

[T-WORK] and [M-WORK] tabs

The input screens for automatic workpiece offset setting are the same as for "Z-AXIS DIRECTION WORK SETUP (PROBE Z-AXIS)," except that the screen title is changed to "Z-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)."

Measurement motion

<1> A rapid movement is made from the current position to the approach point (Y coordinate,Z coordinate).
Here, the approach point (Y coordinate) is the same as "MEASURE POINT Y".
The approach point (Z coordinate) represents ("MEASURE POINT Z" - α) when the measurement direction is "+Z", or the approach point (Z coordinate) represents ("MEASURE POINT Z" + α) when the measurement direction is "-Z".

The subsequent motion is the same as for "Y-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)".

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

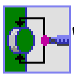
G2122 Q_ P_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;

Measurement result

When G2122 is executed, the result of measurement is output to macro variables for the result of measurement and as the Z coordinate of a specified workpiece origin offset value.

2.9.4 Outside Diameter Measurement

When the probe is oriented in the X-axis direction, the center position of the outside diameter of a circle is measured.

Select  "OUTSIDE DIAMETER WORK SETUP(PROBE X-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- CENTER POINT Y, Z

Enter the correct Y and Z coordinates of the center of a circle by specifying numeric values.

- HEIGHT OF MEAS. PT.

Enter the height of a measurement position in the X-axis direction by specifying a numeric value.
The descriptions of the other items are the same as for "Outside Diameter Measurement" of "WORK SET (PROBE Z-AXIS DIRECTION)".

[T-WORK] tab

This screen is the input screen (for turning) used for automatic workpiece origin offset setting.
This screen enables specification for setting a measured value as a workpiece origin offset value on the turning side.

> **NOTE**
> With the CNC for a machining center, the [T-WORK] tab is not displayed.

- WORK COORD. VALUE Y

Enter the Y coordinate of a measurement position in the specified coordinate system by specifying a numeric value.

- WORK COORD. VALUE Z

Enter the Z coordinate of a measurement position in the specified coordinate system by specifying a numeric value.
The other input items are the same as for "Outside Diameter Measurement" of "WORK SET (PROBE Z-AXIS DIRECTION)"

Processing when the OK range and the feedback range are 0

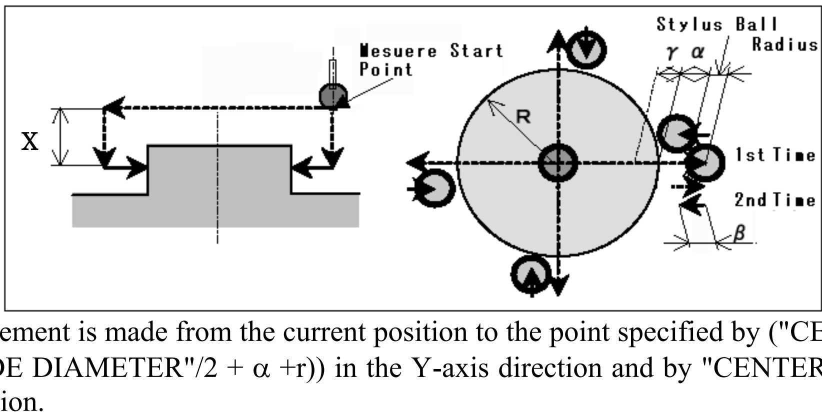
The same processing as for "Outside Diameter Measurement" of "WORK SET (PROBE Z-AXIS DIRECTION)" is performed.

[M-WORK] tab

This screen is the input screen (for milling) used for automatic workpiece origin offset setting.
The contents are the same as for the [T-WORK] tab described earlier.

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT Y" + ("OUTSIDE DIAMETER"/2 + α +r)) in the Y-axis direction and by "CENTER POINT Z" in the Z-axis direction.
<2> In the -X-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<3> In the -X-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<4> If "ON" is selected for "SPINDLE ORIENTATION", spindle orientation is performed here.
<5> In the range (α + γ), a measurement is made at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)

<7> Next, a rapid return movement is made by ε, and a rapid return movement is made in the +X-axis direction to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<8> A rapid movement is made to "CENTER POINT Y", then a movement is made in the -Y-axis direction by the distance ("OUTSIDE DIAMETER"/2 + α + r) at feedrate fa.

<9> A similar measurement is made in the -Y-axis direction and ±Z-axis directions.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of "APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

Motion depending on the number of measurement points

When "MEASUREMENT POINT" is set to 1, a measurement is made in the +Y-axis direction only.

When "MEASUREMENT POINT" is set to 2, a measurement is made in the +Y-axis and -Y-axis directions only.

When "MEASUREMENT POINT" is set to 3, a measurement is made in the +Y-axis, -Y-axis, and +Z-axis directions.

Motion when spindle orientation is enabled

When "SPINDLE ORIENTATION" is set to ON, spindle orientation is performed for each measurement point.

Measurement in the +Y-axis direction → Spindle orientation to the 0° position
Measurement in the -Y-axis direction → Spindle orientation to the 180° position
Measurement in the +Z-axis direction → Spindle orientation to the 270° position
Measurement in the -Z-axis direction → Spindle orientation to the 90° position

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

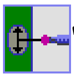
```
G2123 Q_ D_ H_ V_ L_ R_ F_ P_ M_ W_ I_ J_ S_ Y_ U_ A_ B_ K_ E_ ;
```

Measurement result

When G2123 is executed, the center of the circle is found from the measured value, and is output to macro variables for the result of measurement and as a specified workpiece origin offset value.

2.9.5 Inside Diameter Measurement

When the probe is oriented in the X-axis direction, the center position of the inside diameter of a circle is measured.

Select "INSIDE DIAMETER WORK SETUP(PROBE X-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

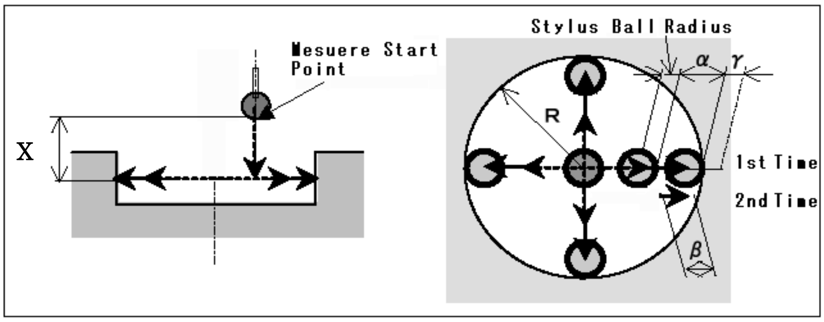
The descriptions of the input items are the same as for "Outside Diameter Measurement".

[T-WORK] and [M-WORK] tabs

The input screens for automatic tool offset setting are the same as for "OUTSIDE DIAMETER MEASUREMENT."

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT Y" + ("INSIDE DIAMETER"/2 - α - r)) in the Y-axis direction and by "CENTER POINT Z" in the Z-axis direction.
<2> In the -X-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<3> Next, a movement is made in the -X-axis direction to the point specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<4> If “ON" is selected for "SPINDLE ORIENTATION", spindle orientation is performed here.
<5> In the range (α + γ) from that point, a measurement is made at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<7> After a rapid return movement is made by ε, a rapid movement is made to the Y coordinate specified by " CENTER POINT Y ", then a movement is made at feedrate fa in the -Y-axis direction by the distance ("INSIDE DIAMETER"/2 - α - r).
<8> A similar measurement is made in the -Y-axis direction and ±Z-axis directions.
<9> A return movement is made by "APROCH DISTANCE" in the X-axis direction.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of "APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

Motion depending on the number of measurement points

The description of motion is the same as for "Outside Diameter Measurement".

Motion when spindle orientation is enabled

The description of motion is the same as for "Outside Diameter Measurement".

G code format

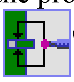
When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2124 Q_ D_ H_ V_ L_ R_ F_ P_ M_ W_ I_ J_ S_ Y_ U_ A_ B_ K_ E_ ;
```

Measurement result

When G2124 is executed, the center of the circle is found from the measured value, and is output to macro variables for the result of measurement and as a specified workpiece origin offset value.

2.9.6 Outside Width Measurement

When the probe is oriented in the X-axis direction, the center position of a projection width is measured.
Select "OUTSIDE WIDTH WORK SETUP(PROBE X-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

- MEASUREMENT DIREC.

Select a measurement axis direction from the soft keys.

- CENTER POINT Y, Z

Enter the correct center coordinates of a projection by specifying numeric values.
For the direction other than the measurement direction, enter the coordinate of a measurement point.
The descriptions of the other input items are the same as for "OUTSIDE DIAMETER MEASUREMENT (PROBE X-AXIS)".

[T-WORK] tab

This screen is the input screen (for turning) used for automatic workpiece origin offset setting.
This screen enables specification for setting a measured value as a workpiece origin offset value on the turning side.

> **NOTE**
> With the CNC for a machining center, the [T-WORK] tab is not displayed.

OK RANGE (±)

Enter an allowable range of errors obtained from measurement, by specifying a numeric value.

if the difference between the center coordinate obtained from measurement and the correct value (input value "CENTER POINT Y" or "CENTER POINT Z") is within this allowable range, the absence of errors is assumed, and no setting is performed as a workpiece origin offset value.

FEED BACK RANGE (±)

If an error obtained from measurement is not within the OK range but is within this feedback range, the measured value is set in the setting destination.
If an error obtained from measurement exceeds the feedback range, an alarm is issued.
The descriptions of the other input items are the same as for "Outside Width Measurement" of "WORK SET (PROBE Z-AXIS DIRECTION)".

Processing when the OK range and the feedback range are 0

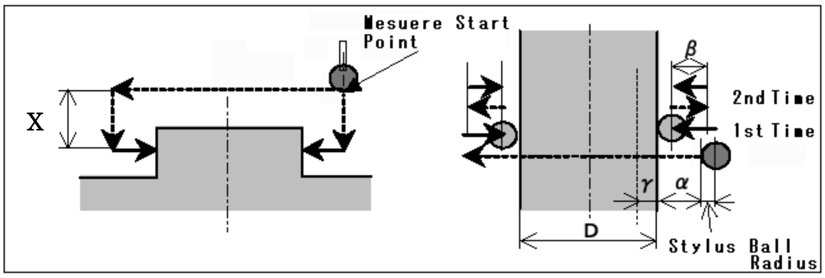
The description of processing is the same as for "Outside Width Measurement" of "WORK SET (PROBE Z-AXIS DIRECTION)".

[M-WORK] tab

This screen is the input screen (for milling) used for automatic workpiece origin offset setting.
The contents are the same as for the [T-WORK] tab described earlier.

Measurement motion

Measurement motion is described below.



<1> For measurement in the Y-axis direction, a rapid movement is made from the current position to the point specified by ("CENTER POINT Y" + ("PROJECTION WIDTH"/2 + α + r)) in the Y-axis direction and by "CENTER POINT Z" in the Z-axis direction. Similarly, for measurement in the Z-axis direction, a rapid movement is made from the current position to the point specified by "CENTER POINT Y" in the Y-axis direction and by ("CENTER POINT Z" + ("PROJECTION WIDTH"/2 + α + r)) in the Z-axis direction.

<2> In the -X-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<3> Then a movement is made in the -X-axis direction to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb. In the range from that position to (α + γ), a measurement is made at feedrate f. (First measurement)

<4> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)

<5> Next, a rapid return movement is made by ε, and a rapid return movement is made in the +X-axis direction to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<6> A rapid movement is then made to the center coordinates. Next, a movement is made to the approach point on the minus (-) side at feedrate fa. Then, a similar measurement is also made in the -Y-axis (-Z-axis) direction.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of "APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

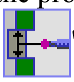
```
G2125 P_ Q_ D_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2125 is executed, the center of the projection width is found from the measured value, and is output to macro variables for the result of measurement and as a specified workpiece origin offset value.

2.9.7 Inside Width Measurement

When the probe is oriented in the X-axis direction, the center position of a groove width is measured.

Select  "INSIDE WIDTH WORK SETUP(PROBE X-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

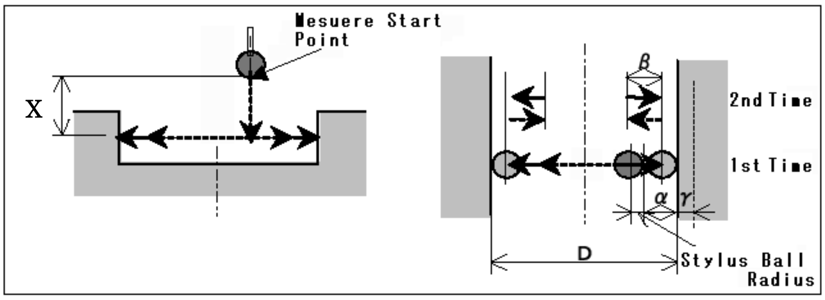
The descriptions of the input items are the same as for "OUTSIDE WIDTH MEASUREMENT (PROBE X-AXIS)".

[T-WORK] and [M-WORK] tabs

The input screens for automatic workpiece offset setting are the same as for "OUTSIDE WIDTH MEASUREMENT (PROBE X-AXIS)."

Measurement motion

Measurement motion is described below.



<1> For measurement in the Y-axis direction, a rapid movement is made from the current position to the point specified by ("CENTER POINT Y" + ("GROOVE WIDTH"/2 - α - r)) in the Y-axis direction and by "CENTER POINT Z" in the Z-axis direction. Similarly, for measurement in the Z-axis direction, a rapid movement is made from the current position to the point specified by "CENTER

POINT Y" in the Y-axis direction and by ("CENTER POINT Z" + ("GROOVE WIDTH"/2 - α - r)) in the Z-axis direction.

<2> In the -X-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<3> In the -X-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.

<4> Then, a measurement is made at feedrate f in the +Y-axis (+Z-axis) direction in the range (α + γ). (First measurement)

<5> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)

<6> A rapid movement is then made to the center coordinates. Next, a movement is made to the approach point on the minus (-) side at feedrate fa. Then, a similar measurement is also made in the -Y-axis (-Z-axis) direction.

<7> A return movement is made by "APROCH DISTANCE" in the X-axis direction.

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of "APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

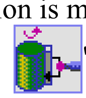
G2126 P_ Q_ D_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;

Measurement result

When G2126 is executed, the center and size of the groove width are found from the measured value, and are output to macro variables for the result of measurement and as a specified workpiece origin offset value.

2.9.8 C-axis Outside Width Measurement

When the probe is oriented in the X-axis direction, the center angle of a projection width in the C-axis direction is measured.

Select  "C-AXIS OUTSIDE WIDTH WORK SETUP(PROBE X-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

NOTE
When absolute coordinates is not rounded in 0 to 360°(prameter No.1006#1=1,#0=1),and measurement range angle is greater than 180°, Outside width measurement and Inside width measurement is not available.

[MOTION] tab

- MEASURE POINT Z, Y

Enter the Z coordinate of a measurement position by specifying a numeric value.

- CENTER ANGLE

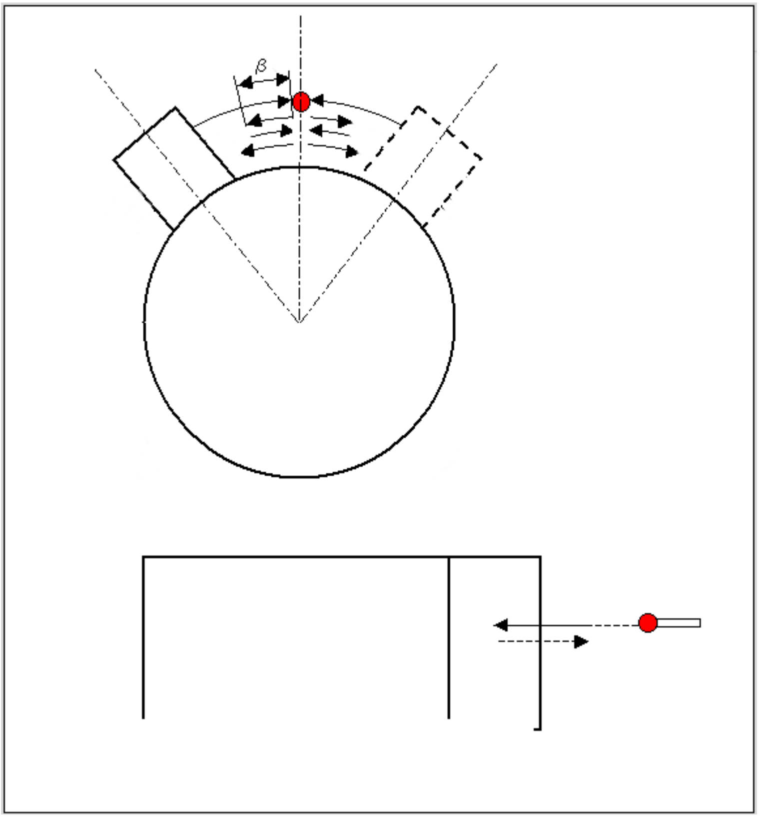
Enter the correct C coordinate of a center angle by specifying a numeric value (in the input unit for angle).
The descriptions of the other input items are the same as for "C-AXIS OUTSIDE WIDTH WORK SETUP" of "WORK SET (PROBE Z-AXIS DIRECTION)".

[T-WORK] and [M-WORK] tabs

The input screens for automatic workpiece offset setting are the same as for "C-AXIS OUTSIDE WIDTH WORK SETUP" of "WORK SET (PROBE Z-AXIS DIRECTION)."

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by "MEASURE POINT Y" and "MEASURE POINT Z".
<2> Next, a rapid movement is made in the C-axis direction to the point ("CENTER ANGLE" - "ANGLE RANGE OF MEAS").
<3> In the -X-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<4> In the -X-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.

<5> In the +C-axis direction, a measurement is made in the range of "ANGLE RANGE OF MEAS" at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<7> Then, a rapid return movement is made by ε, and a rapid return movement is made in the +X-axis direction to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<8> Then, a rapid movement is made in the C-axis direction to the point ("CENTER ANGLE" + "ANGLE RANGE OF MEAS").
<9> A similar measurement is made in the -C-axis direction.

The symbols used above have the following meanings:
fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."
f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
α: Value of "APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

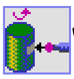
```
G2131 Q_ H_ V_ C_ A_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2131 is executed, the center angle of the projection width is found from the measured value, and is output to macro variables for the result of measurement and as a specified workpiece origin offset value.

2.9.9 C-axis Inside Width Measurement

When the probe is oriented in the X-axis direction, the center angle of a groove in the C-axis direction is measured.

Select  "C-AXIS INSIDE WIDTH WORK SETUP(PROBE X-AXIS)" on the [WORK SET] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

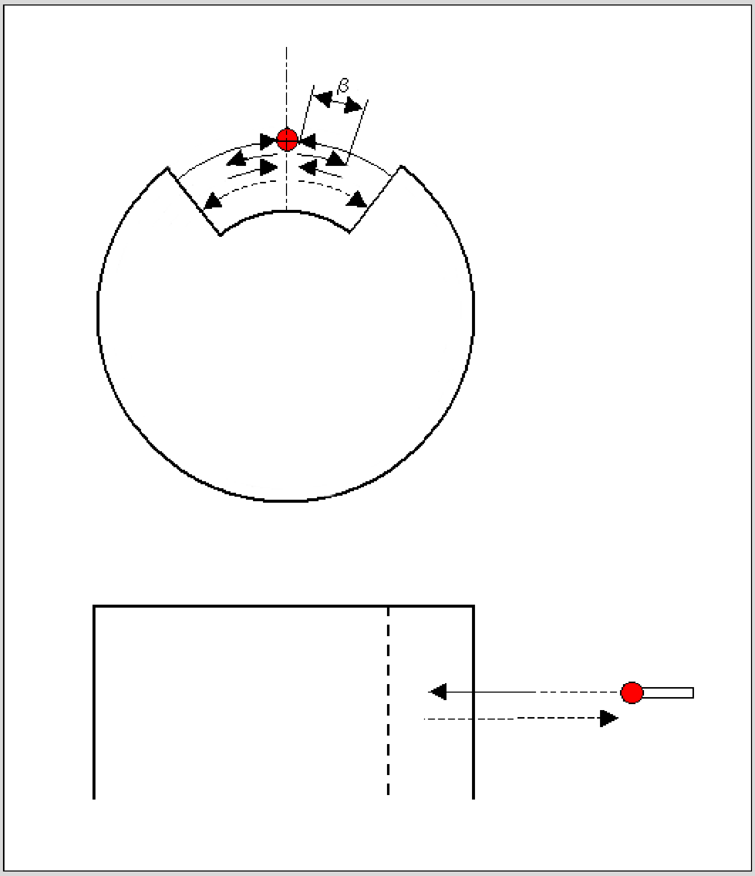
The descriptions of the input items are the same as for "C-AXIS OUTSIDE WIDTH WORK SETUP".

[T-WORK] and [M-WORK] tabs

The input screens for automatic workpiece offset setting are the same as for "C-AXIS OUTSIDE WIDTH WORK SETUP."

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by "MEASURE POINT Z" and "MEASURE POINT Y".
<2> Next, a rapid movement is made in the C-axis direction to the point specified by "CENTER ANGLE".
<3> In the -X-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<4> In the -X-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<5> In the +C-axis direction, a measurement is made in the range of "ANGLE RANGE OF MEAS" at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<7> Then, a rapid movement is made in the C-axis direction to the measurement start point.
<8> A similar measurement is made in the -C-axis direction.
<9> A return movement is made by "APROCH DISTANCE" in the X-axis direction.

The symbols used above have the following meanings:

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of "FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of "APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2132 Q_ H_ V_ C_ A_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

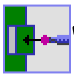
Measurement result

When G2132 is executed, the center angle of the groove width is found from the measured value, and is output to macro variables for the result of measurement and as a specified workpiece origin offset value.

2.10 MEASURE (PROBE X-AXIS DIRECTION)

2.10.1 End Face (X-axis Direction) Measurement

The position of an end face in the X-axis direction is measured.

Select "X AXIS DIRECTION MEASUREMENT(PROBE X-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

As the window title, "X-AXIS DIRECTION MEASUREMENT (PROBE X-AXIS)" is indicated.
The other displayed items are the same as for "X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)".
The detailed descriptions of the input items are the same as for "X-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)".

[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for “X-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS).”

Measurement motion

The description of motion is the same as for X-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)".

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

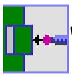
```
G2140 Q_ P_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2140 is executed, the compensation value obtained from the measured value is output to macro variables for the result of measurement and as a specified tool offset value.

2.10.2 End Face (Y-axis Direction) Measurement

The position of an end face in the Y-axis direction is measured.

Select  "Y AXIS DIRECTION MEASUREMENT(PROBE X-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

As the window title, "Y-AXIS DIRECTION MEASUREMENT (PROBE X-AXIS)" is indicated.
The other displayed items are the same as for "Y-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)".
The detailed descriptions of the input items are the same as for "Y-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)".

[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for “Y-AXIS DIRECTION MEASUREMENT(PROBE Z-AXIS).”

Measurement motion

The description of motion is the same as for "Y-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)".

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

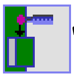
```
G2141 Q_ P_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2141 is executed, the compensation value obtained from the measured value is output to macro variables for the result of measurement and as a specified tool offset value.

2.10.3 End Face (Z-axis Direction) Measurement

The position of an end face in the Z-axis direction is measured.

Select  "Z AXIS DIRECTION MEASUREMENT(PROBE X-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

As the window title, "Z-AXIS DIRECTION MEASUREMENT (PROBE X-AXIS)" is indicated.
The other displayed items are the same as for "Z-AXIS DIRECTION MEASUREMENT (PROBE Z-AXIS)".
The detailed descriptions of the input items are the same as for "Z-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)".

[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for “Z-AXIS DIRECTION MEASUREMENT(PROBE Z-AXIS).”

Measurement motion

The description of motion is the same as for "Z-AXIS DIRECTION WORK SETUP (PROBE X-AXIS)".

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

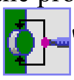
```
G2142 Q_ P_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2142 is executed, the compensation value obtained from the measured value is output to macro variables for the result of measurement and as a specified tool offset value.

2.10.4 Outside Diameter Measurement

When the probe is oriented in the X-axis direction, the outside diameter of a circle is measured.

Select  "OUTSIDE DIAMETER MEASUREMENT(PROBE X-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

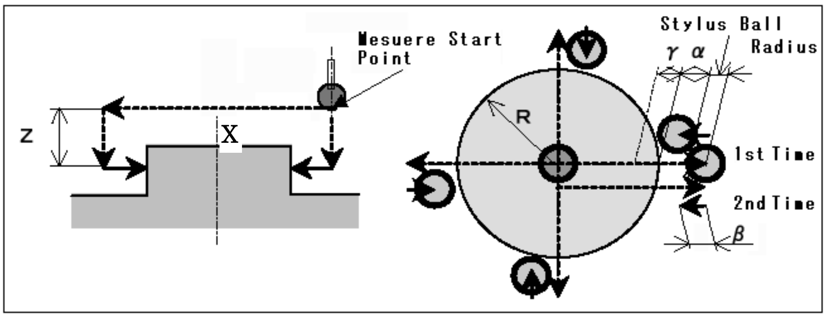
[MOTION] tab

The detailed descriptions of the input items are the same as for "OUTSIDE DIAMETER WORK SETUP (PROBE X-AXIS)".

[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for “OUTSIDE DIAMETER MEASUREMENT(PROBE Z-AXIS).”

Measurement motion



<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT Y" + ("OUTSIDE DIAMETER"/2 + α + r)) in the Y-axis direction and by "CENTER POINT Z" in the Z-axis direction.
<2> In the -X-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<3> In the -X-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<4> If "ON" is selected for "SPINDLE ORIENTATION", spindle orientation is performed here.
<5> In the range of (α + γ), a measurement is made at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by ε, and a rapid return movement is made in the +X-axis direction to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<7> A rapid movement is made to "CENTER POINT Y", then a movement is made in the -Y-axis direction by the distance ("OUTSIDE DIAMETER"/2 + α + r) at feedrate fa.
<8> A similar measurement is made in the -Y-axis direction and ±Z-axis directions.
<9> After of the first measurement, a center position for the second measurement is calculated from the measurement result of each point.

<10>A movement is made in the +Y-axis direction to the position (first measurement position + β) at feedrate fa, then a movement is made in the -X-axis direction to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb. Next, a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<11>Next, a rapid return movement is made by ε, then a rapid return movement is made in the X-axis direction to the position before the start of measurement.
<12>A similar measurement is made in the -Y-axis direction and ±Z-axis directions.

When bit 3 (SHRT) of parameter No. 12380 = 1
<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT Y" + ("OUTSIDE DIAMETER"/2 + α +r)) in the Y-axis direction and by "CENTER POINT Z" in the Z-axis direction.
<2> In the -X-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<3> In the -X-axis direction, a movement is made to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<4> If "ON" is selected for "SPINDLE ORIENTATION", spindle orientation is performed here.
<5> In the range of (α + γ), a measurement is made at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<7> Next, a rapid return movement is made by ε, and a rapid return movement is made in the +X-axis direction to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<8> A rapid movement is made to "CENTER POINT Y", then a movement is made in the -Y-axis direction by the distance ("OUTSIDE DIAMETER"/2 + α + r) at feedrate fa.
<9> A similar measurement is made in the -Y-axis direction and ±Z-axis directions.

The symbols used above have the following meanings:
fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.
fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."
f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
α: Value of “APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."
r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

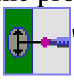
```
G2143 Q_ D_ H_ V_ L_ R_ F_ P_ M_ W_ I_ J_ S_ Y_ U_ A_ B_ K_ E_ ;
```

Measurement result

When G2143 is executed, the size of the circle is found from the measured value, and the compensation value obtained from the difference is output to macro variables for the result of measurement and as a specified tool offset value.

2.10.5 Inside Diameter Measurement

When the probe is oriented in the X-axis direction, the inside diameter of a circle is measured.

Select "INSIDE DIAMETER MEASUREMENT(PROBE X-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

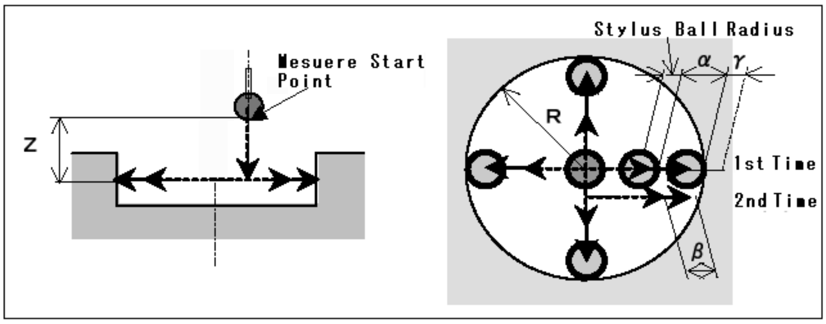
The detailed descriptions of the input items are the same as for "INSIDE DIAMETER WORK SETUP (PROBE X-AXIS)".

[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for "INSIDE DIAMETER MEASUREMENT(PROBE Z-AXIS)."

Measurement motion

Measurement motion is described below.



<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT Y" + ("INSIDE DIAMETER"/2 - α - r)) in the Y-axis direction and by "CENTER POINT Z" in the Z-axis direction.
<2> In the -X-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").
<3> Then, a movement is made in the -X-axis direction to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.
<4> If "ON" is selected for "SPINDLE ORIENTATION", spindle orientation is performed here.
<5> In the range of (α + γ) from that point, a measurement is made at feedrate f. (First measurement)
<6> After a rapid return movement is made by β, a rapid movement is made to "CENTER POINT Y".
<7> A similar measurement is made in the -Y-axis direction and ±Z-axis directions.
<8> After the first measurement, a center position for the second measurement is calculated from the measurement result of each point.
<9> In the +Y-axis direction, a movement is made at feedrate fa to the position (measurement position of the first measurement - β), then a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)
<10>A similar measurement is made in the -Y-axis direction and ±Z-axis directions.
<11>In the X-axis direction, a return movement is made by "APROCH DISTANCE".

When bit 3 (SHRT) of parameter No. 12380 = 1

<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT Y" + ("INSIDE DIAMETER"/2 - α - r)) in the Y-axis direction and by "CENTER POINT Z" in the Z-axis direction.

<2> In the -X-axis direction, a rapid movement is made to the approach point ("HEIGHT OF MEAS. PT." + "APROCH DISTANCE").

<3> Then, a movement is made in the -X-axis direction to the position specified by "HEIGHT OF MEAS. PT." at feedrate fb.

<4> If "ON" is selected for "SPINDLE ORIENTATION", spindle orientation is performed here.

<5> In the range of (α + γ) from that point, a measurement is made at feedrate f. (First measurement)

<6> Next, a rapid return movement is made by β, and a measurement is made at the feedrate specified by "MOVING MEAS. SPEED" in the range from that position to (β + γ). (Second measurement)

<7> After a rapid return movement is made by ε, a rapid movement is made to the Y coordinate specified by " CENTER POINT Y ", then a movement is made at feedrate fa in the -Y-axis direction by the distance ("INSIDE DIAMETER"/2 - α - r).

<8> A similar measurement is made in the -Y-axis direction and ±Z-axis directions.

<9> In the X-axis direction, a return movement is made by "APROCH DISTANCE".

The symbols used above have the following meanings:

fa: Value of "FEED-RATE FOR APPROACHING START POINT" in the measurement condition of the group number specified in "MEASUREMENT COND."
Rapid traverse rate when bit 2 (RPDF) of parameter No. 12380 is set to 1.

fb: Value of "FEED-RATE FOR APPROACHING START POINT" in the axis direction in the measurement condition of the group number specified in "MEASUREMENT COND."

f: Value of “FEED-RATE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

α: Value of “APPROACH DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

β: Value of "ESCAPING DISTANCE FOR 1ST MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

γ: Value of "OVERLAP DISTANCE FOR MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

ε: Value of "ESCAPING DISTANCE FOR 2ND MEASUREMENT" in the measurement condition of the group number specified in "MEASUREMENT COND."

r: Value obtained by dividing ("STYLUS BALL 1ST AXIS DIAMETER" in the calibration data of the group number specified in "MEASUREMENT COND.") by 2

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

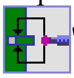
G2144 Q_ D_ H_ V_ L_ R_ F_ P_ M_ W_ I_ J_ S_ Y_ U_ A_ B_ K_ E_ ;

Measurement result

When G2144 is executed, the size of the circle is found from the measured value, and the compensation value obtained from the difference is output to macro variables for the result of measurement and as a specified tool offset value.

2.10.6 Outside Width Measurement

When the probe is oriented in the X-axis direction, the width of a projection is measured.

Select "OUTSIDE WIDTH MEASUREMENT(PROBE X-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

The detailed descriptions of the input items are the same as for "OUTSIDE WIDTH WORK SETUP (PROBE X-AXIS)".

[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for “OUTSIDE WIDTH MEASUREMENT(PROBE Z-AXIS).”

Measurement motion

The description of motion is the same as for "OUTSIDE WIDTH WORK SETUP (PROBE X-AXIS)".

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

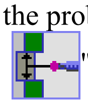
```
G2145 P_ Q_ D_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

When G2145 is executed, the projection width is found from the measured value, and the compensation value obtained from the difference is output to macro variables for the result of measurement and as a specified tool offset value.

2.10.7 Inside Width Measurement

When the probe is oriented in the X-axis direction, the width of a groove is measured.

Select "INSIDE WIDTH MEASUREMENT(PROBE X-AXIS)" on the [MEASURE] tab of the measurement cycle menu screen. The input screen appears.

[MOTION] tab

The detailed descriptions of the input items are the same as for "INSIDE WIDTH WORK SETUP (PROBE X-AXIS)".

[T-TOOL] and [M-TOOL] tabs

The input screens for automatic tool offset setting are the same as for "INSIDE WIDTH MEASUREMENT(PROBE Z-AXIS)."

Measurement motion

The description of motion is the same as for "INSIDE WIDTH WORK SETUP (PROBE X-AXIS)".

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2146 P_ Q_ D_ H_ V_ L_ R_ F_ W_ I_ S_ Y_ U_ J_ K_ E_ ;
```

Measurement result

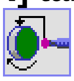
When G2146 is executed, the groove width is found from the measured value, and the compensation value obtained from the difference is output to macro variables for the result of measurement and as a specified tool offset value.

2.10.8 Outside Diameter Measurement (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the outside diameter of the circle is obtained from the average of the results.

> **NOTE**
> This function is enabled when bit 0 (RCR) of parameter No. 27222 is set to 1.

[MOTION] tab

Select  "OUTSIDE DIA. MEASUREMENT-WORK ROTATION (PROBE X)" on the [MEASURE] tab of the measurement cycle menu screen. The measurement operation setting screen appears.
The information displayed in each input item is the same as for "OUTSIDE DIA. MEASUREMENT-WORK ROTATION (PROBE Z)."

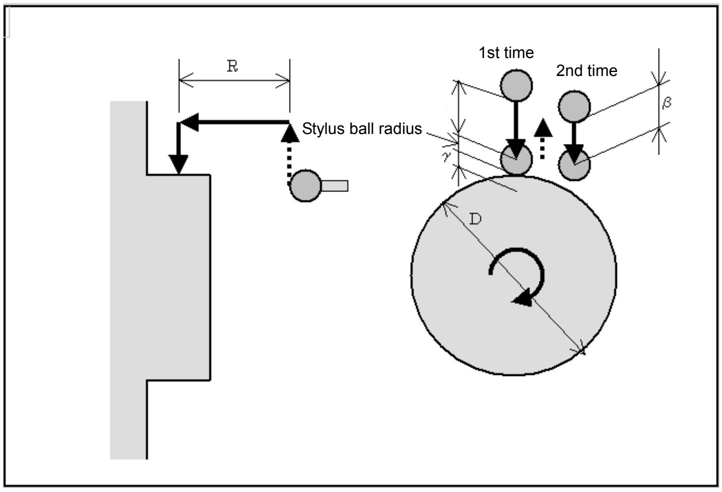
Input screen for automatic tool offset setting

The contents are the same as for “OUTSIDE DIA. MEASUREMENT-WORK ROTATION (PROBE Z).”

Measurement motion

- When rotation axis positioning based on C-axis rotation is used

A measurement operation with the -Z direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified by “STARTING ANGLE.”
<2> A rapid movement is made from the current position to the point specified by ("CENTER POINT Z"+("OUTER"/2+α+r)) in the Z-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<3> A rapid movement is made in the X-axis direction to the approach point (“HEIGHT OF MEAS.PT.”+”APROCH DISTANCE”).
<4> A movement is made in the -X-axis direction to the position specified by “HEIGHT OF MEAS.PT.” at feedrate fb.
<5> A measurement is made in the range (α + γ) at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to (β + γ). (Second measurement)
<7> A rapid return movement is made in the Z-axis direction to the approach point.

<8> The C-axis is rotated by the angle specified by “PITCH ANGLE.”
<9> Steps <5> through <8> above are repeated as many times as specified by “MEASUREMENT POINT.”
<10> Finally, a rapid return movement is made to the approach point ("HEIGHT OF MEAS.PT."+"APROCH DISTANCE") along the X-axis.

> **NOTE**
> Specify a measurement direction in parameter No. 27232.

Meaning	Symbol in the explanation
Feed-rate for approaching start point (in the axis direction)	fb
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ
Escaping distance for 2nd measurement	ε
Stylus ball diameter/2	r

> **NOTE**
> The values of α, β, γ, ε, fb, f are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

- When rotation axis positioning based on the spindle orientation function is used

The measurement operation is the same as for “OUTSIDE DIA. MEASUREMENT-WORK ROTATION (PROBE Z).”

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2153 Q_ D_ H_ V_ L_ R_ N_ M_ F_ P_

Measurement result

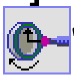
When G2153 is executed, the diameter of the circle is found from the average of the measurement results of individual measurement points then the offset value obtained from the differential from the target value (input item "OUTER") is output to the specified tool offset item and macro variable for the result of measurement.

2.10.9 Inside Diameter Measurement (Work Rotation Type)

By positioning a rotation axis with C-axis rotation or spindle orientation, multiple points on the periphery are measured, and the inside diameter of the circle is obtained from the average of the results.

> **NOTE**
> This function is enabled when bit 0 (RCR) of parameter No. 27222 is set to 1.

[MOTION] tab

Select "INSIDE DIA. MEASUREMENT-WORK ROTATION (PROBE Z)" on the [MEASURE] tab of the measurement cycle menu screen. The measurement operation setting screen appears.
The information displayed in each input item is the same as for "OUTSIDE DIA. MEASUREMENT-WORK ROTATION (PROBE X)."

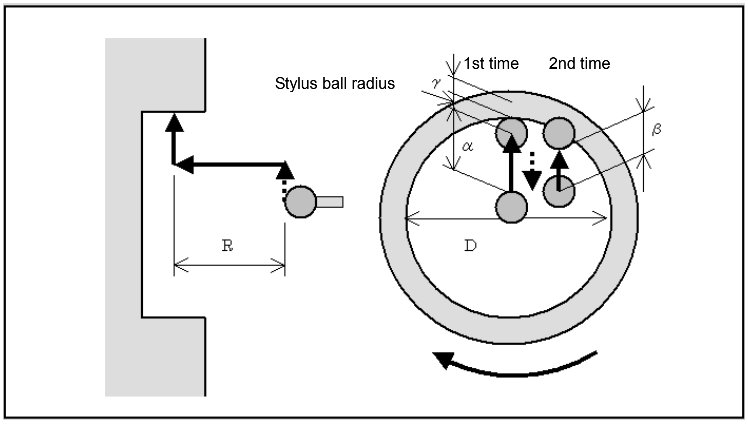
Input screen for automatic tool offset setting

The contents are the same as for “OUTSIDE DIA. MEASUREMENT-WORK ROTATION (PROBE Z).”

Measurement motion

- When rotation axis positioning based on C-axis rotation is used

A measurement operation with the +Z direction specified as the direction of measurement is explained below as an example.



<1> The C-axis is positioned at the angle specified by “STARTING ANGLE.”
<2> A rapid movement is made from the current position to the point specified by ("CENTER POINT Z"+("INNER"/2-α-r)) in the Z-axis direction and by "CENTER POINT Y" in the Y-axis direction.
<3> A rapid movement is made in the X-axis direction to the approach point (“HEIGHT OF MEAS.PT.”+”APROCH DISTANCE”).
<4> A movement is made in the -X-axis direction to the position specified by “HEIGHT OF MEAS.PT.” at feedrate fb.
<5> A measurement is made in the range (α + γ) at feedrate f. (First measurement)
<6> Next, a rapid return movement is made by β then a measurement is made at the feedrate specified by "MOVING MEAS.SPEED" in the range from that position to (β + γ). (Second measurement)
<7> A rapid return movement is made in the Z-axis direction to the approach point.
<8> The C-axis is rotated by the angle specified by “PITCH ANGLE.”
<9> Steps <5> through <8> above are repeated as many times as specified by “MEASUREMENT POINT.”
<10>Finally, a rapid return movement is made to the approach point along the X-axis.

NOTE
Specify a measurement direction in parameter No. 27233.

Meaning	Symbol in the explanation
Feed-rate for approaching start point (in the axis direction)	fb
Feedrate for 1st measurement	f
Approach distance for 1st measurement	α
Escaping distance for 1st measurement	β
Overlap distance for measurement	γ

Meaning	Symbol in the explanation
Escaping distance for 2nd measurement	ε
Stylus ball diameter/2	r

NOTE
The values of α, β, γ, ε, fb, f are specified in the MEASURE CONDITION OF WORK SET/MEASURE window. Refer to section 3.1.3 of this manual.

- When rotation axis positioning based on the spindle orientation function is used

The measurement operation is the same as for "OUTSIDE DIA. MEASUREMENT-WORK ROTATION (PROBE Z)."

G code format

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

G2154 Q_ D_ H_ V_ L_ R_ N_ M_ F_ P_

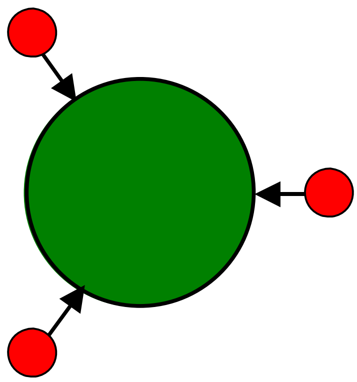
Measurement result

When G2154 is executed, the diameter of the circle is found from the average of the measurement results of individual measurement points then the offset value obtained from the differential from the target value (input item "INNER") is output to the specified tool offset item and macro variable for the result of measurement.

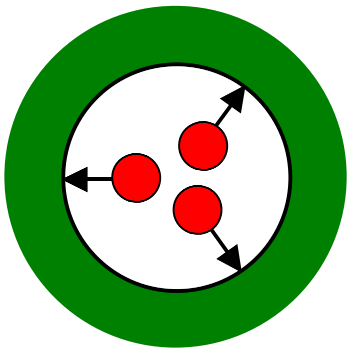
2.11 OTHER FUNCTIONS

2.11.1 Three-Point Measurement of an Arbitrary Angle

In measurement of a stylus ball radius or center offset amount or in measurement of the outside diameter or inside diameter of a circle, an arbitrary angle can be measured. Moreover, a three-point measurement can be made. This means that the center of a half circle can also be measured.



(Measurement of outside diameter of circle)



(Measurement of inside diameter of circle)

NOTE
1. This function is enabled when bit 4 (CANG) of parameter No. 27220 is set to 1.
2. This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

Measurement cycles for which this function is enabled

Select a desired measurement from each of the calibration menu, centering menu, and post-machining inspection menu.

Calibration menu

"STYLUS BALL DIAMETER CALIBRATION" (PROBE Z-AXIS DIRECTION, X-AXIS DIRECTION)
"STYLUS OFFSETS CALIBRATION-A" (PROBE Z-AXIS DIRECTION, X-AXIS DIRECTION)
"STYLUS OFFSETS CALIBRATION-B" (PROBE Z-AXIS DIRECTION, X-AXIS DIRECTION)

Centering menu

"OUTSIDE DIAMETER MEASUREMENT"WORK SETUP (PROBE Z-AXIS DIRECTION, X-AXIS DIRECTION)
"INSIDE DIAMETER MEASUREMENT"WORK SETUP (PROBE Z-AXIS DIRECTION, X-AXIS DIRECTION)

Post-machining inspection menu

"OUTSIDE DIAMETER MEASUREMENT" MEASURE (PROBE Z-AXIS DIRECTION, X-AXIS DIRECTION)
"INSIDE DIAMETER MEASUREMENT" MEASURE (PROBE Z-AXIS DIRECTION, X-AXIS DIRECTION)

Data input screen (stylus ball diameter measurement in the probe Z-axis direction)

Select "STYLUS BALL DIAMETER CALIBRATION (PROBE Z-AXIS)" on the centering menu selection screen of the measurement cycle.

MEASURE		
Input item		Meaning
Q	MEASUREMENT COND.	Measurement condition (centering measurement condition group number)
D	BASE WORK RADIUS	Diameter of a reference workpiece
H	APROCH CENTER PT.X	X coordinate of the center of a circle
V	APROCH CENTER PT.Y	Y coordinate of the center of a circle
L	HEIGHT OF MEAS.PT.	Height of a measurement position in the Z-axis direction
R	APROCH DISTANCE	Move distance from the approach point to a measurement position in the Z-axis direction
N	STARTING ANGLE	Enter a positioning angle for measurement of the first point. By default, 0° is displayed.
M	PITCH ANGLE	Specify a pitch angle between measurement points. By default, 90° is displayed.
F	MOVING MEAS.SPEED	Feedrate at measurement time
P	MEASUREMENT POINT	Number of measurement points (1 to 4)

SETTING		
Input item		Meaning
S	OK RANGE (±)	Specify an allowable range of measurement errors for ignoring the result of measurement. If the difference between the angle obtained from measurement and the correct angular displacement is within this range, the difference is treated as an allowable error and the result of measurement is not set in a macro variable.

SETTING		
Input item		Meaning
Y	FEED BACK RANGE (±)	If an error obtained from the result of measurement is in the range from the OK range to this feedback range, the result of measurement is set in the setting destination. If an obtained error exceeds the feedback range, an alarm is issued.

For the other measurement cycles as well, the following input items are displayed:
Argument N STARTING ANGLE
Argument M PITCH ANGLE

Measurement motion (stylus ball diameter measurement in the probe Z-axis direction)

<1> Place a reference workpiece on a table then execute the measurement cycle.
<2> When the measurement cycle is executed, a rapid movement is made from the current position to the point specified by "APROCH CENTER PT.X" and "APROCH CENTER PT.Y."
<3> A rapid movement is made in the -Z-axis direction to the point ("HEIGHT OF MEAS.PT."+"APROCH DISTANCE").
<4> Next, a movement is made in the -Z-axis direction to the point ("HEIGHT OF MEAS.PT.") at feedrate Fb.
<5> Then, a movement is made by (circle radius - α) in the direction specified by "STARTING ANGLE" at feedrate Fb.
<6> A measurement is made in the range from that position to ($\alpha + \gamma$) at feedrate f. (First measurement)
<7> A rapid return movement is made by β then a measurement is made in the range from that position to ($\beta + \gamma$) at the input feedrate F. (Second measurement)
<8> A rapid return movement is made to "APPROACH CENTER PT.".
<9> A similar measurement is made at positions shifted by "PITCH ANGLE" as many times as specified by "MEASUREMENT POINT."
<10> A return movement is made by "APROCH DISTANCE" in the Z-axis direction.

G code format (stylus ball diameter measurement in the probe Z-axis direction)

When you press the INSERT key after entering necessary data, a G code program in the following format is stored in the machining program memory:

```
G2062 Q_ D_ H_ V_ L_ R_ N_ M_ F_ P_ S_ Y_ ;
```

Measurement result (stylus ball diameter measurement in the probe Z-axis direction)

When G2062 is executed, the result of measurement is output to the specified calibration data "X AXIS DIAMETER" and "Y AXIS DIAMETER".

2.11.2 Tool Length Compensation in Measurement Cycle

When this function is enabled, a measurement cycle can be executed with tool length compensation activated. To execute a measurement cycle when this function is disabled, tool compensation needs to be canceled.
When the [SETING] soft key is pressed in probe length measurement, the result of measurement is set as calibration data. At the same time, the result of measurement is set with the tool offset number specified by parameter No. 27247.

> **NOTE**
> 1 This function is enabled when bit 0 (CMPH) of parameter No. 27220 is set to 1.
> 2 This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

Command of tool length compensation

When the measurement result is feed back to the tool offset, it is possible to execute the following tool length compensation command (G43) after the measured of probe length. To execute tool length compensation command, the macro program with the number set by parameter No.27252 is called when the [SETING] soft key is pressed.
The following command of tool length compensation is output from the macro program.

<1> In case that Direction of the measurement is –Z.
The following command is output and tool length compensation of z-axis direction is enabled.
- (a) Tool length compensation type A.
  G91 G43 Z0 Hbb ; (bb = tool length compensation number specified by parameter No.27247)
- (b) Tool length compensation type B.
  G91 G17 G43 Z0 Hbb;
- (c) Tool length compensation type C.
  G91 G43 Z0 Hbb;

<2> In case that Direction of the measurement is –X.
The following command is output and tool length compensation of x-axis direction is enabled.
- (a) Tool length compensation type A.
  Not execute tool length compensation.
- (b) Tool length compensation type B.
  G91 G17 G43 X0 Hbb;
- (c) Tool length compensation type C.
  G91 G43 X0 Hbb;

2.11.3 Measurement Condition Selection

When bit 5 (GRP) of parameter No. 27224 is set to 1, the item MEASUREMENT COND. can be hidden. In this case, the number of measurement condition groups is assumed to be 1.

> **NOTE**
> This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

2.11.4 Hiding Approach Distance

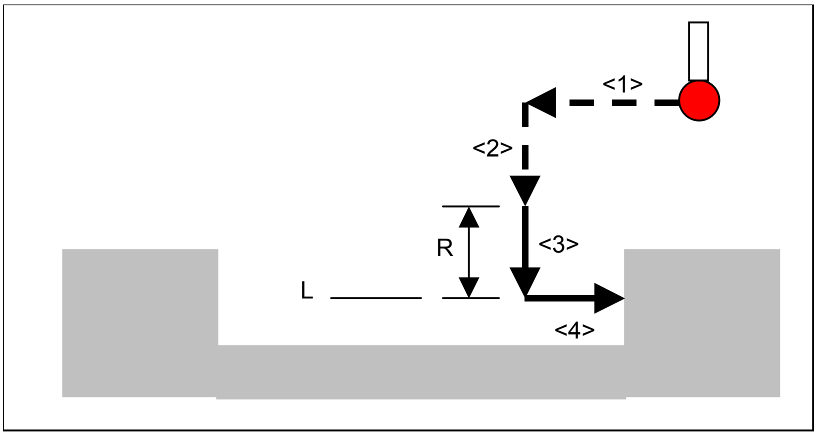
When bit 0 (ZAP) of parameter No. 27224 is set to 1, APROCH DISTANCE for movement in the tool axis direction is not displayed on the data input screen of the measurement cycle. In this case, an approach movement is made with G31 from the Z-axis position (in the case of measurement on the XY plane) before entering into the measurement cycle to the height of a measurement position.

> **NOTE**
> This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

Measurement motion

Approach operation for measurement cycle execution varies, depending on the value of bit 0 (ZAP) of parameter No. 27224, as described below.

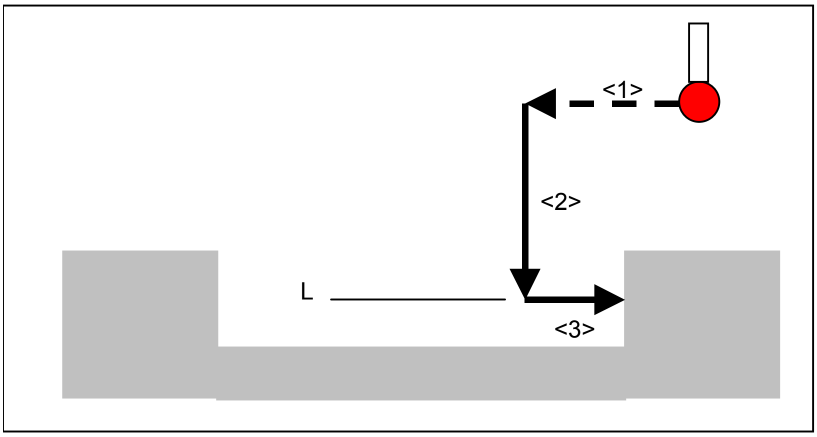
Approach operation when bit 0 of parameter No. 27224 is set to 0 (when this function is disabled)



When a measurement is made on the XY plane:

<1> A rapid movement is made from the current position to the measurement start position for the first point (X and Y coordinates).
<2> A rapid movement is made in the Z-axis direction to the approach point ("HEIGHT OF MEAS.PT."+"APROCH DISTANCE").
<3> A movement is further made in the -Z-axis direction to the position specified by "HEIGHT OF MEAS.PT." with G31.
<4> The first point is measured.

Approach operation when bit 0 of parameter No. 27224 is set to 1 (when this function is enabled)



When a measurement is made on the XY plane:

<1> A rapid movement is made from the current position to the measurement start position for the first point (X and Y coordinates).
<2> A movement is made to the position specified by "HEIGHT OF MEAS.PT." with G31.
<3> The first point is measured.

> ⚠ **CAUTION**
> In outside diameter measurement or projection width measurement, the tool retracts in the tool axis direction to the height used before the start of measurement, before moving to each measurement point.

2.11.5 Hiding the OK Range and Feedback Range

When bit 1 (RAN) of parameter No. 27224 is set to 1, the items OK RANGE and FEED BACK RANGE are not displayed on the measurement cycle input screen. When this function is enabled, the result of measurement is fed back at all times.

> **NOTE**
> This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

2.11.6 Setting of a Range for Disabling Feedback

Even if the results of measurements lie within a specified feedback rang in a measurement cycle of a machining program, the feedback capability can be disabled.
In this case, however, the results of measurements are recorded in a measurement result list.

Setting the feedback mode to ON/OFF

In the range specified by the four-digit G codes indicated below, feedback operation is disabled even if the results of measurements lie within the feedback range after measurement cycle execution.

G2090 Feedback mode OFF
G2091 Feedback mode ON

> **NOTE**
> At the time of power-on or reset, the feedback mode is ON.

Example of use

```
O2999
;
G2003Q5.D30.H0.V0.L-10.R20.F10.S0.003Y1. ;
;
G2090;
;
G2040P1.Q5.H100.V0.L-10.R20.F10.W7.I2.
S0.005Y1.U7.J4.K0.005E1. ;
G2040P1.Q5.H-100.V0.L-10.R20.F10.W7.I2.
S0.005Y1.U7.J4.K0.005E1.;
G2040P1.Q5.H120.V50.L-10.R20.F10.W7.I2.
S0.005Y1.U7.J4.K0.005E1.;
;
G2091;
;
```

In this range, feedback operation is disabled.

2.11.7 Setting a Range for Disabling an NG Alarm

In a measurement cycle of a machining program, the issue of an alarm can be disabled if the result of measurement exceeds the feedback range. This function can be used to continue execution of a machining or measurement program without issuing an alarm even when the result of a particular measurement exceeds the feedback range.

NG alarm mode OFF/ON

In the range specified by the following G 4-digit codes, no alarm is issued even when the result of measurement cycle execution exceeds the feedback range:

G2092 NG alarm mode OFF
G2093 NG alarm mode ON

Usage example

```
O2999
;
G2003Q5.D30.H0.V0.L-10.R20.F10.S0.003Y1. ;
;
```

An alarm is issued when the feedback range is exceeded.

```
G2092;
;
G2040P1.Q5.H100.V0.L-10.R20.F10.W7.I2.
S0.005Y1.U7.J4.K0.005E1. ;
G2040P1.Q5.H-100.V0.L-10.R20.F10.W7.I2.
S0.005Y1.U7.J4.K0.005E1.;
G2040P1.Q5.H120.V50.L-10.R20.F10.W7.I2.
S0.005Y1.U7.J4.K0.005E1.;
;
```

No alarm is issued even when the feedback range is exceeded.

```
G2093;
;
    :
    :
    :
```

An alarm is issued when the feedback range is exceeded.

2.11.8 The Number of the Measurement Operation is Omitted to One Time

The number of the measurement operation in each measurement point can be omitted from two times to one time.

Measurement kind that can be omitted

<1> Twice measurement operation is omitted to one time in parameter No27228#2=1 at the following measurement cycle.

Mesurement cycle		G code
Tool mesurement	Milling tool measurement (Tool Z-AXIS Direction)	2010
	Turning tool measurement (Tool Z-AXIS Direction)	2011
	Milling tool measurement (Tool Z-AXIS Direction, Noncontact type)	2012
	Milling tool measurement (Tool Z-AXIS Direction)	2110
	Turning tool measurement (Tool X-AXIS Direction)	2111
	Milling tool measurement (Tool X-AXIS Direction, Noncontact type)	2112

<2> Twice measurement operation is omitted to one time in parameter No27228#3=1 at the following measurement cycle.

Mesurement cycle		G code
Calibration	Touch sensor position measurement (Tool Z-axis direction)	2000

	Mesurement cycle	G code
	Probe length measurement (Probe Z-axis direction)	2001
	Stylus ball diameter measurement (Probe Z-axis direction)	2002
	Stylus ball center offset measurement-A (Probe Z-axis direction)	2003
	Stylus ball center offset measurement-B (Probe Z-axis direction)	2004
	Stylus ball diameter measurement (Work rotation type) (Probe Z-axis direction)	2005
	Stylus ball center offset measurement-A (Work rotation type) (Probe Z-axis direction)	2006
	Stylus ball center offset measurement-B (Work rotation type) (Probe Z-axis direction)	2007
	Stylus ball diameter measurement (Probe Z-axis direction) (Arbitrary angle)	2062
	Stylus ball center offset measurement-A (Probe Z-axis direction) (Arbitrary angle)	2063
	Stylus ball center offset measurement-B (Probe Z-axis direction) (Arbitrary angle)	2064
	Touch sensor position measurement (Tool X-axis direction)	2100
	Probe length measurement (Probe X-axis direction)	2101
Calibration	Stylus ball diameter measurement (Probe X-axis direction)	2102
	Stylus ball center offset measurement-A (Probe X-axis direction)	2103
	Stylus ball center offset measurement-B (Probe X-axis direction)	2104
	Stylus ball diameter measurement (Work rotation type) (Probe X-axis direction)	2105
	Stylus ball center offset measurement-A (Work rotation type) (Probe X-axis direction)	2106
	Stylus ball center offset measurement-B (Work rotation type) (Probe X-axis direction)	2107
	Stylus ball diameter measurement (Probe X-axis direction) (Arbitrary angle)	2162
	Stylus ball center offset measurement-A (Probe X-axis direction) (Arbitrary angle)	2163
	Stylus ball center offset measurement-B (Probe X-axis direction) (Arbitrary angle)	2164
Work set	End face (X-axis direction) measurement (Probe Z-axis direction)	2020
	End face (Y-axis direction) measurement (Probe Z-axis direction)	2021
	End face (Z-axis direction) measurement (Probe Z-axis direction)	2022
	Outside diameter measurement (Probe Z-axis direction)	2023
	Inside diameter measurement (Probe Z-axis direction)	2024
	Outside width measurement (Probe Z-axis direction)	2025
	Inside width measurement (Probe Z-axis direction)	2026
	Measurement of the outside of a corner (Probe Z-axis direction)	2027
	Measurement of the inside of a corner (Probe Z-axis direction)	2028
	Measurement of the angle of a slanted workpiece (Probe Z-axis direction)	2029
	C-axis outside width measurement (Probe Z-axis direction)	2031
Work set	C-axis inside width measurement (Probe Z-axis direction)	2032
	Workpiece setting error measurement (Probe Z-axis direction)	2033
	Outside diameter measurement (Probe Z-axis direction) (Arbitrary angle)	2073
	Inside diameter measurement (Probe Z-axis direction) (Arbitrary angle)	2074
	End face (X-axis direction) measurement (Probe X-axis direction)	2120
	End face (Y-axis direction) measurement (Probe X-axis direction)	2121
	End face (Z-axis direction) measurement (Probe X-axis direction)	2122
	Outside diameter measurement (Probe X-axis direction)	2123
	Inside diameter measurement (Probe X-axis direction)	2124
	Outside width measurement (Probe X-axis direction)	2125
	Inside width measurement (Probe X-axis direction)	2126
	Measurement of the outside of a corner (Probe X-axis direction)	2127
	Measurement of the inside of a corner (Probe X-axis direction)	2128
	Measurement of the angle of a slanted workpiece (Probe X-axis direction)	2129
	C-axis outside width measurement (Probe X-axis direction)	2131
	C-axis inside width measurement (Probe X-axis direction)	2132
	Workpiece setting error measurement (Probe X-axis direction)	2133
	Outside diameter measurement (Probe X-axis direction) (Arbitrary angle)	2173
	Inside diameter measurement (Probe X-axis direction) (Arbitrary angle)	2174

Mesurement cycle		G code
Measure	End face (X-axis direction) measurement (Probe Z-axis direction)	2040
	End face (Y-axis direction) measurement (Probe Z-axis direction)	2041
	End face (Z-axis direction) measurement (Probe Z-axis direction)	2042
	Outside diameter measurement (Probe Z-axis direction)	2043
	Inside diameter measurement (Probe Z-axis direction)	2044
	Outside width measurement (Probe Z-axis direction)	2045
	Inside width measurement (Probe Z-axis direction)	2046
	Outside diameter measurement (Probe Z-axis direction) (Work rotation type)	2053
	Inside diameter measurement (Probe Z-axis direction) (Work rotation type)	2054
	Outside diameter measurement (Probe Z-axis direction) (Arbitrary angle)	2083
	Inside diameter measurement (Probe Z-axis direction) (Arbitrary angle)	2084
	End face (X-axis direction) measurement (Probe X-axis direction)	2140
Measure	End face (Y-axis direction) measurement (Probe X-axis direction)	2141
	End face (Z-axis direction) measurement (Probe X-axis direction)	2142
	Outside diameter measurement (Probe X-axis direction)	2143
	Inside diameter measurement (Probe X-axis direction)	2144
	Outside width measurement (Probe X-axis direction)	2145
	Inside width measurement (Probe X-axis direction)	2146
	Outside diameter measurement (Probe X-axis direction) (Work rotation type)	2153
	Inside diameter measurement (Probe X-axis direction) (Work rotation type)	2154
	Outside diameter measurement (Probe X-axis direction) (Arbitrary angle)	2183
	Inside diameter measurement (Probe X-axis direction) (Arbitrary angle)	2184

Measurement motion

It explains two measurement operation and one measurement operation as an example of "work set of X-axis direction (Probe Z-axis direction)".
Measurement operation becomes the following by the parameter.
Measurement motion is described below.

- In case of parameter No 27228#2=0 (measurement twice)

<1> Tool moves from the current position to the approach point (X coordinate,Y coordinate) in rapid traverse.
Here, the approach point (X coordinate) means ("MEASURE POINT X" - α) when the measurement direction is "+X", or the approach point (X coordinate) means ("MEASURE POINT X" + α) when the measurement direction is "-X". The approach point (Y coordinate) is the same as "MEASURE POINT Y".

<2> In the Z-axis direction, tool moves to the point ("MEASURE POINT Z" + "APROCH DISTANCE") in rapid traverse.

<3> In the Z-axis direction, tool moves to "MEASURE POINT Z" in feedrate fb.

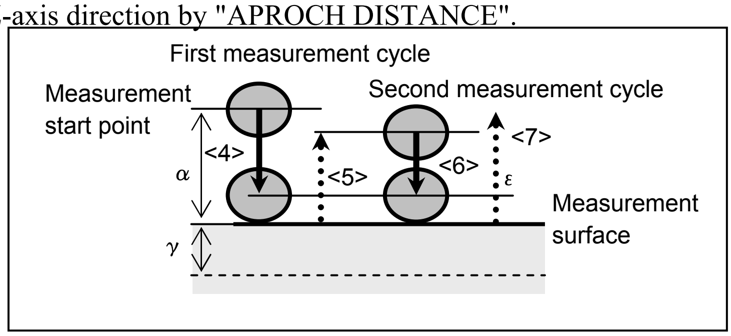
<4> In the range from the approach point to (α + γ - stylus ball radius r), measurement is executed in feedrate f. (First measurement)

<5> Return by β in rapid traverse rate.

<6> In the range from the return point to (β + γ), measurement is executed in feedrate MOVING MEAS. SPEED. (Second measurement)

<7> Return to the X-axis direction by ε.

<8> Return to the Z-axis direction by "APROCH DISTANCE".



- In case of Parameter No 27228#2=1 (measurement once)

<1> Tool moves from the current position to the approach point (X coordinate,Y coordinate) in rapid traverse.
Here, the approach point (X coordinate) means ("MEASURE POINT X" - α) when the measurement direction is "+X", or the approach point (X coordinate) means ("MEASURE POINT X" + α) when the measurement direction is "-X". The approach point (Y coordinate) is the same as "MEASURE POINT Y".

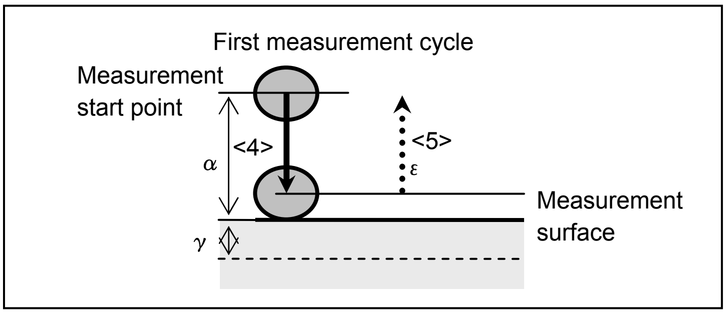
<2> In the Z-axis direction, tool moves to the point ("MEASURE POINT Z" + "APROCH DISTANCE") in rapid traverse.

<3> In the Z-axis direction, tool moves to "MEASURE POINT Z" in feedrate fb.

<4> In the range from the approach point to (α + γ - stylus ball radius r), measurement in feedrate f. (First measurement)

<5> Returns to the X-axis direction by ε.

<6> Returns to the Z-axis direction by "APROCH DISTANCE".



2.11.9 Automatic Output of Tool Rotation Command in Tool Measurement

Tool rotation command is automatic output in the measurement of rotary tool.
This function is used for rotating the tool in order to measure with accuracy

This function is available for the following measurement.

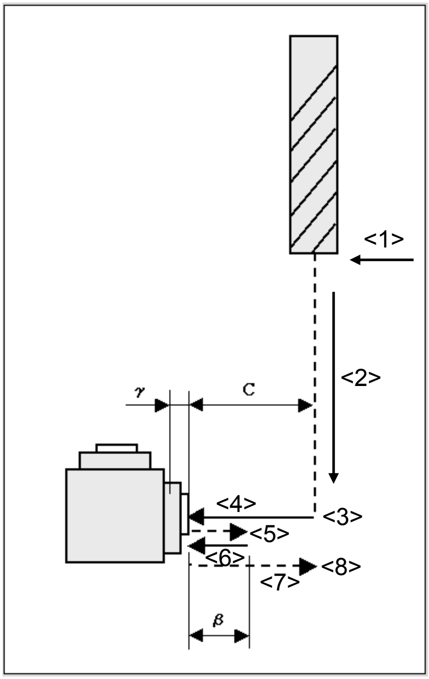
- Milling tool measurement (Tool Z-axis direction)
- Milling tool measurement (Tool Z-axis direction・Non-touch)
- Milling tool measurement (Tool X-axis direction)
- Milling tool measurement (Tool X-axis direction・Non-touch)

Measurement

- Milling tool measurement (Tool Z-Axis direction)
  The following motions of tool rotate and stop are added for this fucntion.
  - After moving to the measurement start point (approach point), start tool rotation
  - At the end of escape after completing measurement, stop tool rotation

The meaning of symbols used in the following explanation is as follows.

Meaning	Symbol in the explanation
Feedrate for the 1st measurement	f
Escaping distance for the 1st measurement	β
Overlap distance for measurement	γ
Feedrate for the 2nd measurement	F
Esacaping distance for the 2nd measurement	ε
Clearance	C
Offset amount in the tool length direction	OFS_H
Offset amount in the tool radius direction	OFS_D



<1> From the current position, tool moves to the approach point X and Y at the rapid traverse rate. Here, the approach point X and Y represents X and Y coordinate of the “sensor position for measurement in the –X direction” of the touch sensor position in the specified measurement condition.

<2> In the –Z axis direction, tool moves to the approach point Z at the rapid traverse rate. Here, the approach point Z represents (Z coordinate of the “sensor position for measurement in the –X direction” of the touch sensor position in the specified measurement condition) + C + OFSH.

<3> Tool starts rotating with the specified direction and speed. In case that no rotating a tool is specified, tool does not rotate.

<4> In the range from the approach point to (C + γ), the measurement is made at feedrate f. (First measurement)

<5> A rapid return movement is made by β. (Second measurement)

<6> Measurement is made in the range from the position <5> to (β + γ) at the specified feedrate F. (Second measurement)

<7> A rapid return movement is made by ε in the +Z axis direction.

<8> In case that a tool was rotated at step <3>, stop rotating tool.

- Milling tool measurement (Tool Z-Axis direction, Non-touch)
  On the motion of start/end of rotating tool, it’s same as for milling tool measuremnt (Tool Z-axis direction).

- Milling tool measurement (Tool X-Axis direction)
  On the motion of start/end of rotating tool, it's same as for milling tool measuremnt (Tool Z-axis direction).

- Milling tool measurement (Tool X-Axis direction, Non-touch)
  On the motion of start/end of rotating tool, it's same as for milling tool measuremnt (Tool Z-axis direction).

G code format

<1> G code format of milling tool measurement (Tool Z-axis direction) (G2010)
The argument of tool rotation command (N) and tool rotaion speed (T) are added to G2010 command.

T system: **G2010 P_Q_C_F_ H_D_V_R_L_Z_ N_T_W_B_I_S_Y;**

M system: **G2010 P_Q_C_F_ H_D_V_R_L_Z_ N_T_U_A_J_K_E;**

Input item	Address	Meaning
TOOL ROTATION COMMAND	N	Tool rotation command is non or existence. Tool rotation direction in case of rotating a tool (1=Non, 2=Forward, 3=Reverse)
TOOL ROTATION SPEED	T	Tool rotation speed (Data range 0 to 99999999)

<2> G code format of milling tool measurement (Tool Z-axis direction, Non-contact type) (G2012)
The argument of Tool rotation command (N) and Tool rotaion speed (T) are added to G2012 command.

G2012 P_Q_C_F_ H_D_V_R_L_Z_ N_T_W_B_I_S_Y_U_A_J_K_E;

<3> G code format of milling tool measurement (Tool X-axis direction) (G2110)
The argument of Tool rotation command (N) and Tool rotaion speed (T) are added to G2110 command.

T system: **G2110 P_Q_C_F_ H_D_V_R_L_Z_ N_T_W_B_I_S_Y;**

M system: **G2110 P_Q_C_F_ H_D_V_R_L_Z_ N_T_U_A_J_K_E;**

<4> G code format of milling tool measurement (Tool X-axis direction, Non-contact type) (G2112)
The srgument of Tool rotation command (N) and Tool rotaion speed (T) are added to G2112 command.

G2112 P_Q_C_F_ H_D_V_R_L_Z_ N_T_W_B_I_S_Y_U_A_J_K_E;

DATA INPUT SCREEN OF MEASUREMENT CYCLE

In case this function is available, on the [MEASURE] tab screen, "TOOL ROTATION CMD" and "TOOL ROTATION SPEED" are displayed newly.

<1> Milling tool measurement (Tool Z-axis direction)

Input item Address		Meaning
N	TOOL ROTATION COMMAND	Tool rotation command is non or existence. Tool rotation direction in case of rotating a tool
T	TOOL ROTATION SPEED	Tool rotation speed

Input item	Address	Indispensability	Default value	Data range
TOOL ROTATION CMD	N	○	Non	1:Non, 2:Forward, 3:Reverse
TOOL ROTATION SPEED (*1)	T	(*2)	—	0 to 99999999

(*1) In case “Non” is specified for “TOOL ROTATIN CMD”, this input item is not displayed.

(*2) In case “Forward” or “Reverse” is specified for “TOOL ROTATION CMD”, this input item has to be entered.

<2> On the other Milling tool measurement (Tool Z-axis direction:Non-contact type, Tool X-axis direction, Tool X-axis direction:Non-contact type) also, they are simillar to <1>.

The spindle rotate/stop command format

Please refer to “The spindle rotate/stop command format” described in “1.6.8 Automatic output of tool rotation command in tool measurement”.

Customizing the spindle rotate/stop command

Please refer to “Customizing the spindle rotate/stop command” described in “1.6.8 Automatic output of tool rotation command in tool measurement”.

2.11.10 Tool Measurement with Multi-step Signals

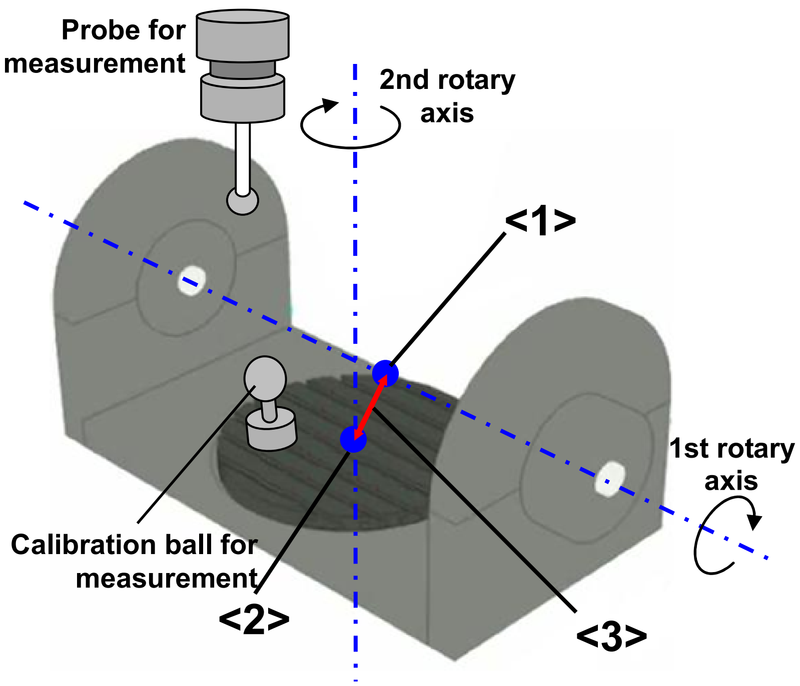
Independent skip signal can be used for the measurement cycle. Please refer to "1.6.9 Tool measurement with multi-step skip signals".

3 MEASUREMENT CYCLE FOR ROTARY AXIS POSITION CALIBRATION IN 5-AXIS MACHINE

3.1 OUTLINE

Generally, in 5 axis machine or 4 axis machine, center position of 1st rotary axis and 2nd rotary axis is different from the theoretical position because of assembly error or thermal growth of machine.
By using this function, center position of rotary axis of 5-axis machine or 4-axis machine can be measured easily.
In addition, the measurement results are set to the parameter for setting of the position of rotary table (No.19700~No.19702) and the parameter for setting of intersection offset vector (No.19703~No.19705) automatically by using this function.
As a result, the gap of center position of rotary axis can be corrected.

(Procedure)
<1> Center position of 1st rotary axis is measured
<2> Center position of 2nd rotary axis is measured
<3> The vector from 1st rotary axis to 2nd rotary axis (Intersection offset vector) is calculated



3.1.1 Required Model

The required model to use this function is as follows.

(1) FANUC Series 0*i*-MODEL F
(2) FANUC Series 30*i*/31*i*/32*i*-MODEL B

3.1.2 Available Machining Configuration

This function is available when the following machining configuration is satisfied.

(1) Three basic axes form the right-hand Cartesian coordinate system.
(2) System control type is machine center system.
(3) The machine type of 5-axis machine or 4-axis machine is table rotation type.
(4) The direction of rotary axis isn’t inclined.
(5) The direction of mounted probe is the direction of Z axis.
(6) The basic three axes and the axis names of rotary axis are as follows.
<1> The basic three axes are X, Y and Z.
<2> The rotary axis is either A, B or C.

3.2 NECESSARY SETTING

3.2.1 Necessary Parameter Setting

It is necessary to set the following parameters.

Parameter No.	Setting value	Meaning
1020 (X axis of basic three axes)	88	Program axis name for each axis (X axis of basic three axes)
1020 (Y axis of basic three axes)	89	Program axis name for each axis (Y axis of basic three axes)
1020 (Z axis of basic three axes)	90	Program axis name for each axis (Z axis of basic three axes)
1020 (rotary axis)	Either of 65, 66 or 67	Program axis name for each axis (rotary axis)
1025 (basic three axes, rotary axis)	0	Program axis name 2 for each axis
1026	0	Program axis name 3 for each axis
19666	(*1)	Tool holder offset value
19680	12	Mechanical unit type is table rotation type
19681	(*1)	Controlled-axis number for the first rotation axis
19682	Either of 1, 2 or 3	Axis direction of the first rotation axis isn’t inclined
19684	(*1)	Rotation direction of the first rotation axis
19685	(*1)	Rotation angle when the first rotation axis is a hypothetical axis
19686	(*1)	Controlled-axis number for the second rotation axis
19687	Either of 1, 2 or 3	Axis direction of the second rotation axis isn’t inclined
19689	(*1)	Rotation direction of the second rotation axis
19690	(*1)	Rotation angle when the second rotation axis is a hypothetical axis

Parameter No.	Setting value	Meaning
19696#0	(*1)	The first rotation axis is an ordinary rotation axis(0) / a hypothetical axis(1)
19696#1	(*1)	The second rotation axis is an ordinary rotation axis(0) / a hypothetical axis(1)
19697	3	Reference tool axis direction is positive Z-axis direction
19698	0	Angle when the reference tool axis direction is tilted (reference angle RA)
19699	0	Angle when the reference tool axis direction is tilted (reference angle RB)
19700	(*1)	Rotary table position (X-axis of the basic three axes)
19701	(*1)	Rotary table position (Y-axis of the basic three axes)
19702	(*1)	Rotary table position (Z-axis of the basic three axes)
19703	(*1)	Intersection offset vector between the first and second rotation axes of the table (X-axis of the basic three axes)
19704	(*1)	Intersection offset vector between the first and second rotation axes of the table (Y-axis of the basic three axes)
19705	(*1)	Intersection offset vector between the first and second rotation axes of the table (Z-axis of the basic three axes)
19754#7	1	When the parameters Nos. 19681 to 19714 are set, the rotation axis position used as the reference is machine coordinates
27229#0	1	Measurement cycle for rotary axis position calibration is available.
27260	Arbitrary(*2)	Start number of macro variable area (500 consecutive areas) for calculating
27229#1	Arbitrary	The calculation result of measurement cycle for rotary axis position calibration is not reflected (0) or reflected (1) in the parameter.
27261	Arbitrary	OK range in Measurement cycle for rotary axis position calibration.
27262	Arbitrary	Feed back range in Measurement cycle for rotary axis position calibration.
27263	Arbitrary	Combination that shares measurement result in Measurement cycle for rotary axis position calibration(*3)

(*1) The machine configuration when machine is designed, or the value when machine is measured before.
(*2) Input the start number for macro variable area as much as 500. Default value is 11500.
(*3) Set the combination that shares the measurement result, in measurement cycle for rotary axis position calibration.

Setting = (The value of P for the 2nd rotary axis)×10 + (The value of P for the 1st rotary axis)

Measuring at the position of P that corresponds to the ten's place or the one's place, the measurement result is also used as a measurement result at the position of P that becomes the pair.
As a result, the measurement operation can be omitted from six times to five times, and the cycle time can be reduced. When 0 is set to this parameter, the measurement operation is not omitted.

(Example) Parameter No.27263 is set to 23
- Measuring at the P3 for 1st rotary axis, the measurement result is also used as a measurement result at the P2 for 2nd rotary axis. Therefore, a measurement of P2 for 2nd rotary axis can be omitted.
- Measuring at the P2 for 2nd rotary axis, the measurement result is also used as a measurement result at the P3 for 1st rotary axis. Therefore, a measurement of P3 for 1st rotary axis can be omitted.

3.2.2 Setting of Measurement Conditions, Calibration Data

Set the following data on “SETTINGS” screen.

* “SETTINGS” screen is displayed by the following operations.
<1> Press the soft key [>] on several times until the soft key [setting] is displayed.
<2> Press the soft key [setting]. “SETTINGS” screen is displayed.

(1) Set up group number of work set / measure condition

(Operation)

<1> Select [MEASURE COND] tab on the “SETTINGS” screen. Measurement conditions menu is displayed.
<2> Select “SETTING” on the measurement conditions menu.

(Details of setting)

Set the following data on “SETTING OF MEASURE CONDITION” screen.

Input item	Meaning
GROUP NUMBER OF WORK SET/MEASURE COND.	Multiple groups of measurement conditions can be set so that those groups can be referenced in centering, post-machining inspection, and probe calibration. Set a value greater than 1 in this item to change the measurement condition according to the type of probe used with a machine that allows the use of probes with different forms. Up to six groups can be set. Set 1 in this item to use only one measurement condition group.
Other input item	Not necessary to input.

(2) Set up movement of a probe in radius direction

(Operation)

<1> Select [MEASURE COND] tab on the “SETTINGS” screen. Measurement conditions menu is displayed.
<2> Select “WORK SET / MEASURE A” on the measurement conditions menu. “MEASURE CONDITON OF WORK SET / MEASUREA” screen is displayed.
<3> Select [RADIUS DIREC] tab.

(Details of setting)

Set the following data on “MEASURE CONDITON OF WORK SET / MEASUREA” screen.

Input item	Meaning
FEED-RATE FOR APPROACHING START POINT	Input feed rate “fa” in the following figure.
Other input item	Not necessary to input.

(3) Set up movement of a probe in axis direction
(Operation)
<1> Select [MEASURE COND] tab on the “SETTINGS” screen. Measurement conditions menu is displayed.
<2> Select “WORK SET / MEASURE A” on the measurement conditions menu. “MEASURE CONDITON OF WORK SET / MEASUREA” screen is displayed.
<3> Select [AXIS DIRECTI] tab.

(Details of setting)
Set the following data on “MEASURE CONDITON OF WORK SET / MEASUREA” screen.

Input item	Meaning
FEED-RATE FOR 1ST MEASURMENT	Input feed rate “f1” in the following figure.
APPROACH DISTANCE FOR 1ST MEASURMENT	Input distance “α” in the following figure.
ESCAPING DISTANCE FOR 1ST MEASURMENT	Input distance “β” in the following figure.
OVERLAP DISTANCE FOR MEASURMENT	Input distance “γ” in the following figure.
FEED-RATE FOR APPROACHING START POINT	Input feed rate “fb” in the following figure.
Other input item	Not necessary to input.

(4) Set up group number of work set / measure calibration
(Operation)
<1> Select [CALIBRATION] tab on the “SETTINGS” screen. Calibration menu is displayed.
<2> Select “SETTING” on the calibration menu.

(Details of setting)
Set the following data on “SETTING OF MEASURE CONDITION” screen.

Input item	Meaning
GROUP NUM. OF WORK SET/MEASURE CALIB	Multiple groups of probe calibration data can be set so that those groups can be referenced in centering and post-machining inspection. Set a value greater than 1 in this item to set calibration data for each probe when using a machine that allows the use of several probes with different forms. Up to six groups can be set. Set 1 in this item to use only one calibration data group.
Other input item	Not necessary to input.

(5) Set up probe form data

(Operation)

<1> Select [CALIBRATION] tab on the “SETTINGS” screen. Calibration menu is displayed.

<2> Select “PROBE FORM A” on the calibration menu. “PROBE FORM A” screen is displayed.

<3> Select [SET VAL.] tab.

(Details of setting)

Set the following data on “PROBE FORM A” screen.

Input item	Meaning
PROBE LENGTH	Input probe length.
STYLUS BALL 1ST AXIS DIAMETER	Input stylus diameter. This is distance r in the following figure.
STYLUS BALL 1ST AXIS OFFSETS	In the case that the stylus ball shifts from the center of the spindle, input the position of the stylus ball seen from the center of the spindle(X axis direction).
STYLUS BALL 2ND AXIS OFFSETS	In the case that the stylus ball shifts from the center of the spindle, input the position of the stylus ball seen from the center of the spindle(Y axis direction).
Other input item	Not necessary to input.

(6) Set up datum sphere form data

(Operation)

<1> Select [CALIBRATION] tab on the “SETTINGS” screen. Calibration menu is displayed.

<2> Select “DATUM SPHERE” on the calibration menu. “DATUM SPHERE” screen is displayed.

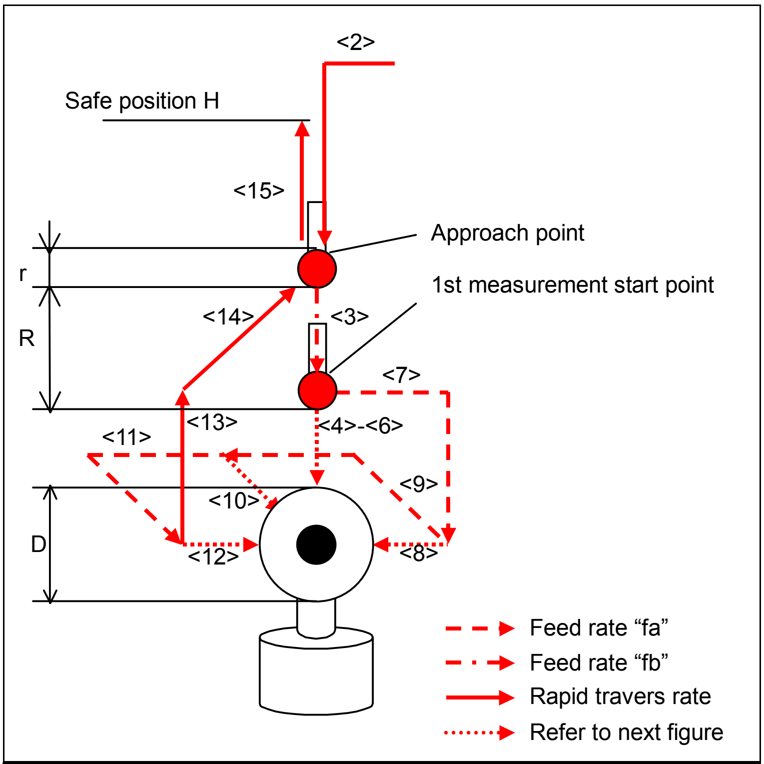
<3> Select [SET VAL.] tab.

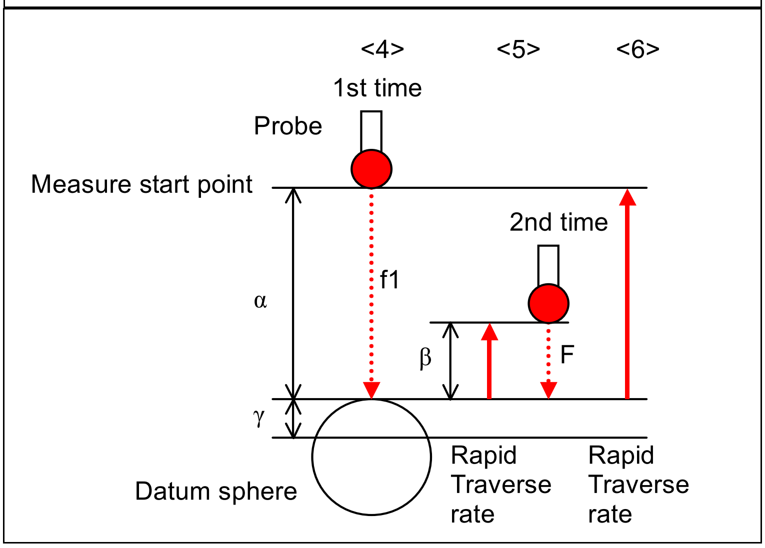
(Details of setting)

Set the following data on “DATUM SPHERE” screen.

Input item	Meaning
SPHERE DIAMETER	Input the diameter of datum sphere. This is distance “D” in the following figure. (*1)
CENTER MAC. POS. X OF SPHERE	Input the machine coordinate value (X axis) of the center the datum sphere.
CENTER MAC. POS. Y OF SPHERE	Input the machine coordinate value (Y axis) of the center the datum sphere.
CENTER MAC. POS. Z OF SPHERE	Input the machine coordinate value (Z axis) of the center the datum sphere.
ANG. OF 1ST ROT. AXIS	Input the angle of 1st rotary axis when the center the datum sphere is measured.
ANG. OF 2ND ROT. AXIS	Input the angle of 2nd rotary axis when the center the datum sphere is measured.

(*1) Input the diameter by the unit of the millimeter, even when parameter No.0#2=1 (inch).


<2>
Safe position H
<15>
Approach point
1st measurement start point
r
R
<14>
<3>
<7>
<13>
<4>-<6>
<11>
<9>
<10>
D
<12>
<8>
Feed rate “fa”
Feed rate “fb”
Rapid travers rate
Refer to next figure


<4>
<5>
<6>
1st time
Probe
Measure start point
2nd time
f1
α
β
F
γ
Rapid Traverse rate
Rapid Traverse rate
Datum sphere

3.3 PROGRAMMING OF MEASUREMENT CYCLE

The program of measurement cycle for rotary axis position calibration in 5-axis machine is composed of the following two cycles.
<1> G2890 : measurement cycle for rotary axis position calibration
<2> G2891 : rotary axis position calibration cycle

(Example of program)

```
G2890 Q1. R10. F5. V0. H100. C1. P1. M-45. S0. A0. ;
G2890 Q1. R10. F5. V0. H100. C1. P2. M0. S0. A0. ;
G2890 Q1. R10. F5. V0. H100. C1. P3. M45. S0. A0. ;
G2890 Q1. R10. F5. V0. H100. C2. P1. M0. S0. A0. ;
G2890 Q1. R10. F5. V0. H100. C2. P2. M0. S120. A0. ;
G2890 Q1. R10. F5. V0. H100. C2. P3. M0. S240. A0. ;
G2891 E1. ;
```

<1> measurement cycle for rotary axis position calibration

<2> rotary axis position calibration cvcle

3.3.1 Creating Method of G2890 Cycle

By the following procedure, measurement cycle for rotary axis position calibration is created.
Repeat the following <1> - <4> procedure 3 times for 1 rotary axis.
In case of 5-axis machine, Repeat the following <1> - <4> procedure 6 times, because there are 2 rotary axis.

(Procedure)

<1> Select [CALIBRATION] tab on measurement cycle menu. The item of “MAES. OF ROT. AXIS POS. CALIB” is displayed.
<2> Select “MAES. OF ROT. AXIS POS. CALIB”. The creating screen of the G2890 cycle is displayed.
<3> According to guidance figure, input data to the items of measurement motion.
<4> Press the [NXTMSC] soft key or [insert] soft key. Then ,G2890 block is inserted to the program.

(Example of created program)

- In case of 5 axis machine

```
G2890 Qq Rr Ff Vv Hh C1 P1 Mm Ss Aa ;
G2890 Qq Rr Ff Vv Hh C1 P2 Mm Ss Aa ;
G2890 Qq Rr Ff Vv Hh C1 P3 Mm Ss Aa ;
G2890 Qq Rr Ff Vv Hh C2 P1 Mm Ss Aa ;
G2890 Qq Rr Ff Vv Hh C2 P2 Mm Ss Aa ;
G2890 Qq Rr Ff Vv Hh C2 P3 Mm Ss Aa ;
```

- In case of 4 axis machine

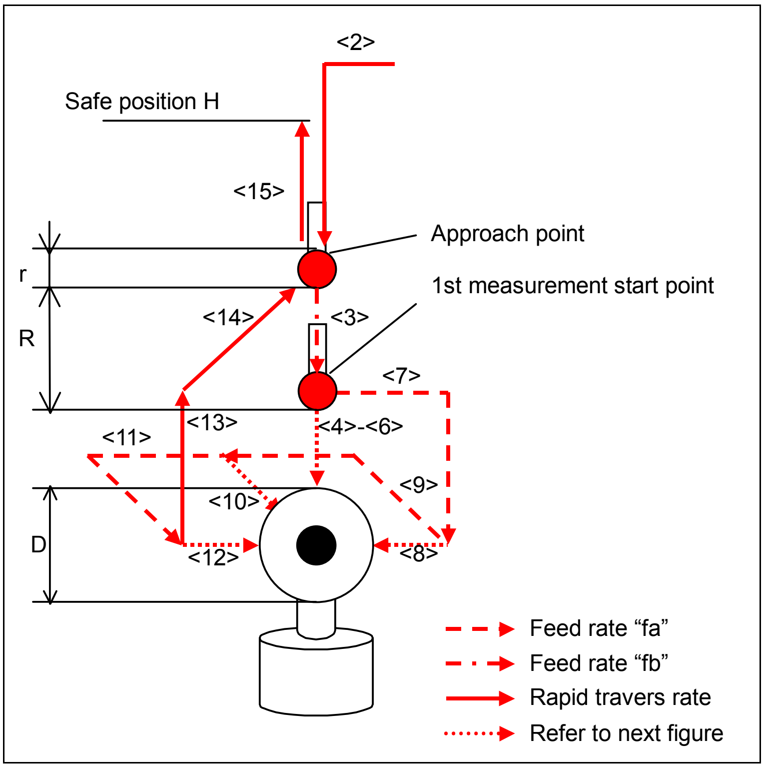
```
G2890 Qq Rr Ff Vv Hh P1 Mm Aa ;
G2890 Qq Rr Ff Vv Hh P2 Mm Aa ;
G2890 Qq Rr Ff Vv Hh P3 Mm Aa ;
```

3.3.1.1 Operation on the screen for creating G2890 cycle

Input data to the items according to guidance figure.
An additional explanation is as follows.

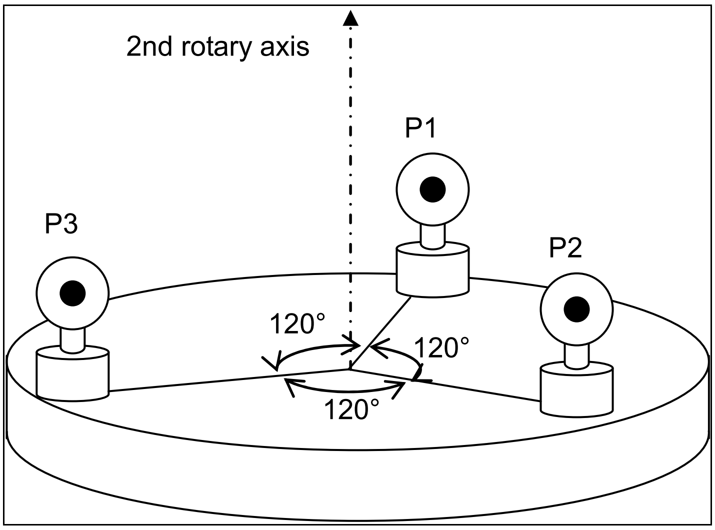
(1) [MOTION] tab

Input item		Meaning
V	ESCAPE TO SAFE POS.	Select whether a movement is made ("YES") or is not made ("NO") in the Z axis direction to "SAFE POSITION H" at the end of the following <3.4.1 Motion of G2890 Cycle>.Select with soft key.
H	SAFE POSITION	This is "SAFE POSITION H" in the following figure In this function, <3.4.1 Motion of G2890 Cycle> is executed several times. Input machine coordinates of Z axis with which the machine doesn't interfere in the axis movement that steps over each measurement.

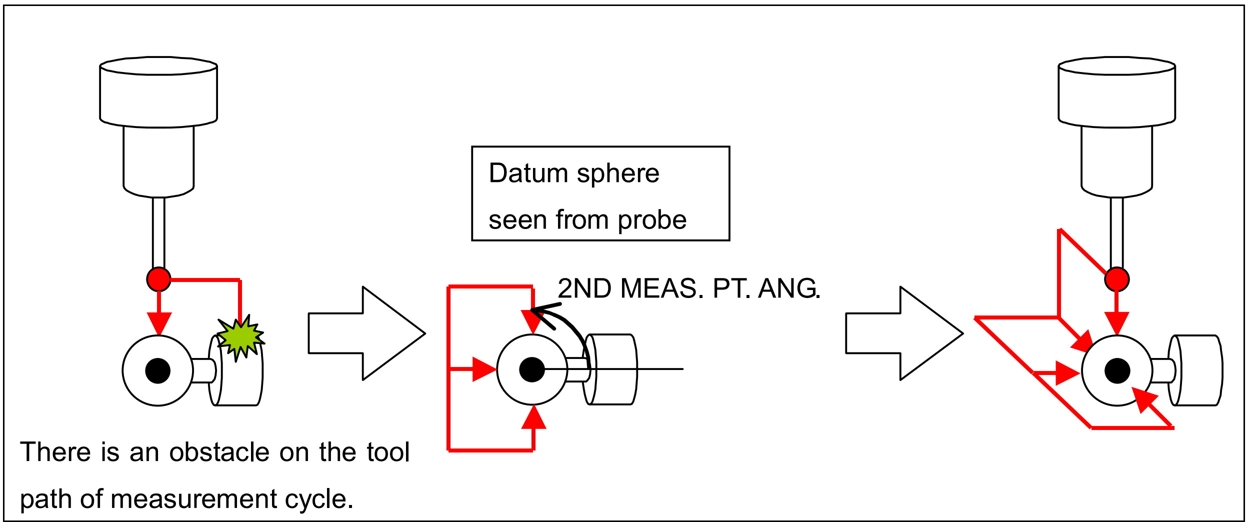


(2) [MEAS. POS.] tab

Input item		Meaning
C	MEASURE. ROT. AXIS	Specify the rotary axis to be measured. This input item is displayed in the case of 5-axis machine (both parameters IA1,IA2(No.19696#0, #1) is set 0). It is necessary to measure each rotary axis at 3 points (P1, P2, P3).
M	1ST ROT. AXIS ANG. / ROT. AXIS ANG.	Specify the angle of the rotary axis when the measurement is executed. <1> in case of 5 axis machine (both parameter IA1,IA2(No.19696#0, #1) is 0), input “1ST ROT. AXIS ANG. “. <2> in case of 4 axis machine (Either parameter IA1 or IA2 (No.19696#0, #1) is 1), input “ROT. AXIS ANG. “. Input machine coordinates with which the position of datum sphere at P1, P2, P3 are as far from each other as possible. The farther they are from each other, the higher the precision of the calculation after measurement is. When C=2 (the rotary axis to be measured is 2nd rotary axis) is set, This value must be the same at P1, P2, P3. Input machine coordinates with which machine do not interfere.
S	2ND ROT. AXIS ANG.	Specify the angle of the 2nd rotary axis when the measurement is executed. Input machine coordinates with which the position of datum sphere at P1, P2, P3 are as far from each other as possible (refer to following figure). The farther they are from each other, the higher the precision of the calculation after measurement is. When C=1 (the rotary axis to be measured is 1st rotary axis) is set, This value must be the same at P1, P2, P3. Input machine coordinates with which machine do not interfere. (In case of 4 axis machine (Either parameter IA1 or IA2 (No.19696#0, #1) is 1), This item is not displayed.)



Input item		Meaning
A	2ND MEAS. PT. ANG.	Input the angle(refer to following figure) with which machine do not interfere in the <3.4.1 Motion of G2890 Cycle> (interference with a probe and a shank of a calibration ball etc.). In the case that "2ND MEAS. PT. ANG." is 0, the position of 2nd measurement point seen from the 1st point is in +X-axis direction. In the case that "2ND MEAS. PT. ANG." is set a value, the position is rotated counterclockwise on XY plane from +X-axis by the value. The positions of 3rd and 4th points are rotated counterclockwise by the value, too. In the case that this item is not input, "2ND MEAS. PT. ANG." is 0. The differences between the angle of 2nd-3rd point and 3rd-4th point are fixed to 90 degrees.



3.3.2 Creating Method of G2891 Cycle

Rotary axis position calibration cycle is created by the following procedure.

<1> Select [CALIBRATE] tab on the [INSERT MEASUREMENT CYCLE] menu. "ROT. AXIS POSITION CALIB." appears.
<2> Select "ROT. AXIS POSITION CALIB.". Creation screen of G2891 cycle is displayed.
<3> When the soft key [INSERT] is pressed, G2891 block is inserted to the program.

3.3.3 Restrictions at Programming

(1) Modal G codes that allow specification of this measurement cycle
This measurement cycle can be specified in the modal G code states listed below.
Edit the program to become the state in the modal states listed below.
When this measurement cycle in modal states other than these is specified, the alarm(MC3723)" COMMAND MODEIS WRONG" is generated.

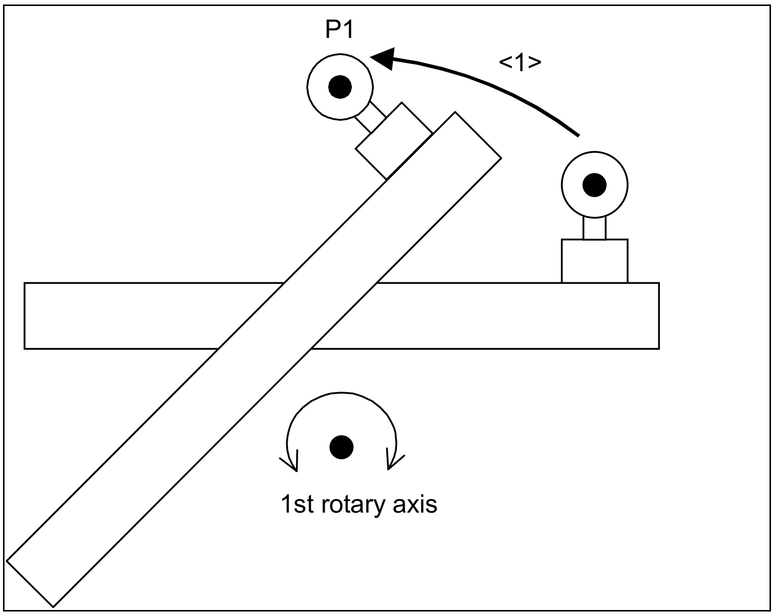
<1> Polar coordinate interpolation mode cancel (G13.1,G113)
<2> Polar coordinate command mode cancel (G15)
<3> Tool radius/tool nose radius compensation cancel (G40)
<4> Normal direction control cancel (G40.1)
<5> Tool length compensation cancel (G49)
<6> Scaling cancel (G50)
<7> Programmable mirror image cancel (G50.1)
<8> Polygon turning cancel (G50.2)
<9> Rotary table dynamic fixture offset cancel (G54.2P0)
<10> Workpiece setting error compensation cancel (G54.4P0)
<11> Cutting mode (G64)
<12> Macro modal code cancel (G67)
<13> Coordinate system rotation / 3-dimensional coordinate system conversion cancel (G69)
<14> Canned cycle cancel (G80)
<15> Feed per minute (G94)
<16> Constant surface speed control cancel (G97)

3.4 MOTION OF THE MEASUREMENT CYCLE

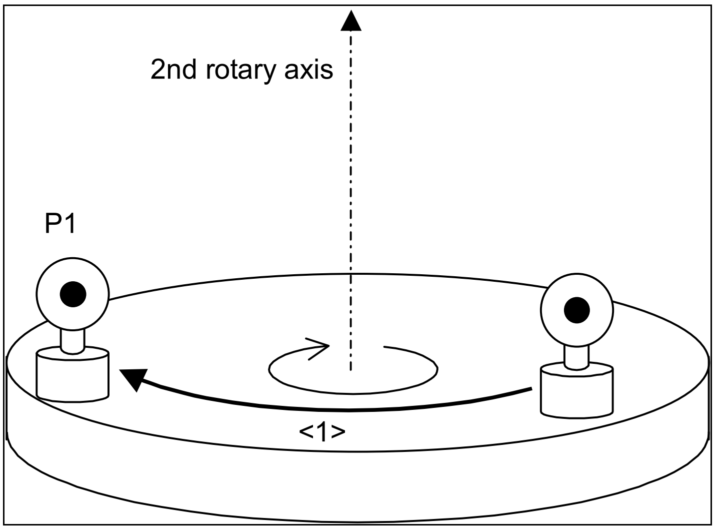
3.4.1 Motion of G2890 Cycle

The following measurement motion is generated when G2890 cycle is executed.

<1> A rapid movement is made from the current position to the position input to "1ST ROT. AXIS ANG." and "2ND ROT. AXIS ANG.".



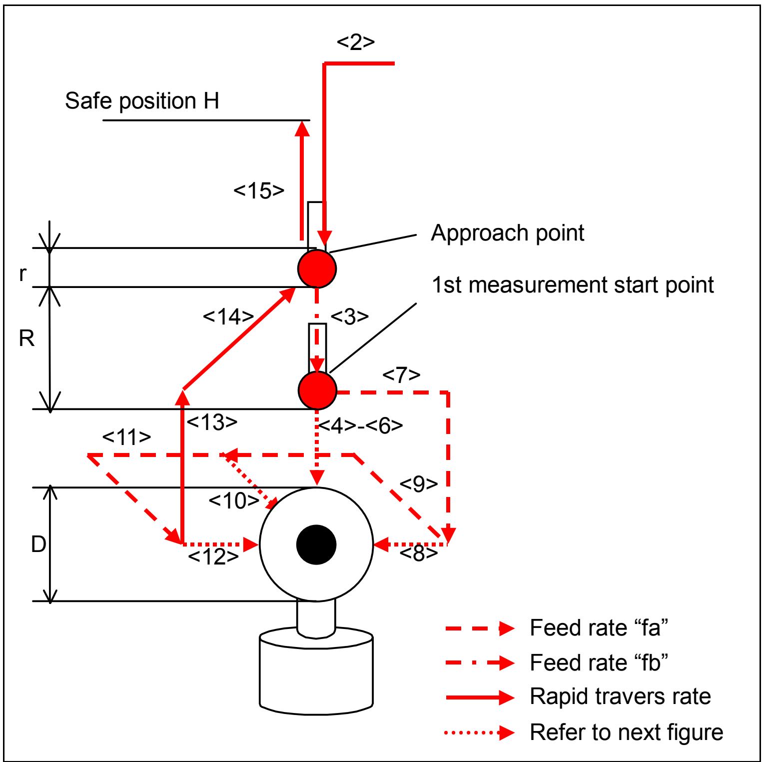
In case of the 1st rotary axis



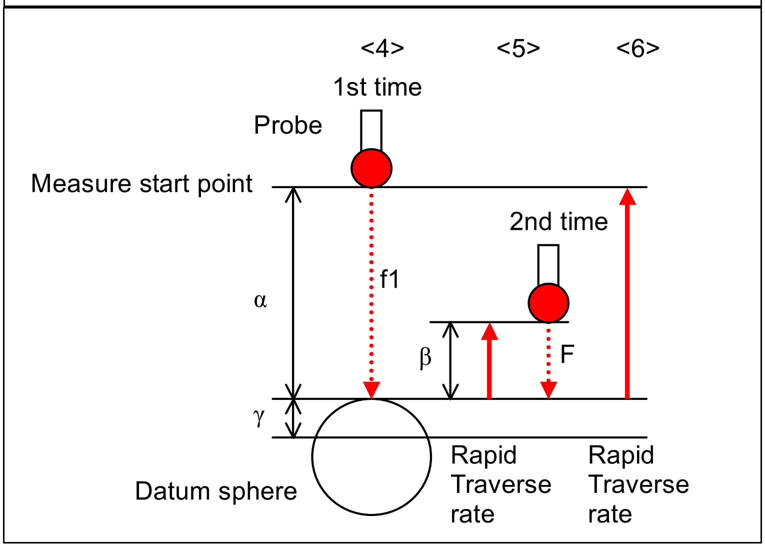
In case of the 2nd rotary axis

<2> A rapid movement is made from the current position to the approach point (X coordinate, Y coordinate).
The approach point is a point which is “APROCH DISTANCE R” away from “1ST MEAS. STRT PT.” toward +Z-axis direction.
A rapid movement is made in the Z-axis direction to the approach point.
<3> A movement is made to “1ST MEAS. STRT PT.” at feed rate fb.
<4> A measurement is made in the -Z axis direction and in the range of (α+γ) at feed rate f1. (First measurement)
<5> Next, a rapid return movement is made by β, and a measurement is made in the -Z axis direction and in the range of (β+γ) at feed rate F. (Second measurement)
<6> A return movement is made to “1ST MEAS. STRT PT.”.
<7> To move to the 2nd measurement point, a movement is made in the +X axis direction(*1) by (D/2+α+r) at feed rate fa, and in the -Z axis direction by (D/2+α+r) at feed rate fa.
<8> A measurement of the 2nd point is made in the -X axis direction(*1).
The measurement is similar to the 1st point <4>-<6>.
<9> To move to the 3rd measurement point, a movement is made in the +Y axis direction(*1) by (D/2+α+r) at feed rate fa, and in the -X axis direction by (D/2+α+r) at feed rate fa.
<10>A measurement of the 3rd point is made in the -Y axis direction(*1).
The measurement is similar to the 1st point <4>-<6>.
<11>To move to the 4th measurement point, a movement is made in the -X axis direction(*1) by (D/2+α+r) at feed rate fa, and in the -Y axis direction by (D/2+α+r) at feed rate fa.
<12>A measurement of the 4th point is made in the +X axis direction(*1).
The measurement is similar to the 1st point <4>-<6>.
<13>A rapid movement is made in the +Z axis direction by (D/2+α+r).
<14>A rapid movement is made to the approach point.
<15>In the case that “SAFE POSITION H” is “YES”, a rapid movement is made in the Z axis direction to “SAFE POSITION H”.

(*1) The direction can be changed with “2ND MEAS. PT. ANG.”.



<2>
Safe position H
<15>
Approach point
1st measurement start point
r
R
<14>
<3>
<7>
<13>
<4>-<6>
<11>
<10>
<9>
D
<12>
<8>
Feed rate "fa"
Feed rate "fb"
Rapid travers rate
Refer to next figure



<4>
<5>
<6>
1st time
Probe
Measure start point
2nd time
f1
α
β
F
γ
Datum sphere
Rapid Traverse rate
Rapid Traverse rate

3.4.2 Motion of G2891 Cycle

When G2891 cycle is executed, the result measured by G2890 cycle is recorded to the following parameters and the macro variables.

(1) Parameter

Parameter No.	Meaning
19700	Rotary table position (X axis of basic three axes)
19701	Rotary table position (Y axis of basic three axes)
19702	Rotary table position (Z axis of basic three axes)
19703	Intersection offset vector between the first and second rotation axes of the table (X axis of basic three axes)
19704	Intersection offset vector between the first and second rotation axes of the table (Y axis of basic three axes)
19705	Intersection offset vector between the first and second rotation axes of the table (Z axis of basic three axes)

(2) Macro variable

Measurement result	Macro variable
Difference between measured value and NC parameter (No.19700) : Center position of 1st rotary axis (X-axis)	#[(Value of No.27260) + 0]
Difference between measured value and NC parameter (No.19701) : Center position of 1st rotary axis (Y-axis)	#[(Value of No.27260) + 1]
Difference between measured value and NC parameter (No.19702) : Center position of 1st rotary axis (Z-axis)	#[(Value of No.27260) + 2]
Difference between measured value and NC parameter (No.19703) : Intersection offset vector (X-axis)	#[(Value of No.27260) + 3]
Difference between measured value and NC parameter (No.19704) : Intersection offset vector (Y-axis)	#[(Value of No.27260) + 4]
Difference between measured value and NC parameter (No.19705) : Intersection offset vector (Z-axis)	#[(Value of No.27260) + 5]
NC parameter (No.19700) : Center position of 1st rotary axis (X-axis)	#[(Value of No.27260) + 6]
NC parameter (No.19701) : Center position of 1st rotary axis (Y-axis)	#[(Value of No.27260) + 7]
NC parameter (No.19702) : Center position of 1st rotary axis (Z-axis)	#[(Value of No.27260) + 8]
NC parameter (No.19703) : Intersection offset vector (X-axis)	#[(Value of No.27260) + 9]
NC parameter (No.19704) : Intersection offset vector (Y-axis)	#[(Value of No.27260) + 10]
NC parameter (No.19705) : Intersection offset vector (Z-axis)	#[(Value of No.27260) + 11]
Setting value : Center position of 1st rotary axis (X-axis)	#[(Value of No.27260) + 12]
Setting value : Center position of 1st rotary axis (Y-axis)	#[(Value of No.27260) + 13]
Setting value : Center position of 1st rotary axis (Z-axis)	#[(Value of No.27260) + 14]
Setting value : Intersection offset vector (X-axis)	#[(Value of No.27260) + 15]
Setting value : Intersection offset vector (Y-axis)	#[(Value of No.27260) + 16]
Setting value : Intersection offset vector (Z-axis)	#[(Value of No.27260) + 17]
Cause ID1 of alarm (MC3726)	#[(Value of No.27260) + 18]
Cause ID2 of alarm (MC3726)	#[(Value of No.27260) + 19]
Cause ID3 of alarm (MC3726)	#[(Value of No.27260) + 20]
Judgment (“Nothing is done”(0), “Within the OK range”(1), “Within the feedback range”(2), “NG”(-1))	#[(Value of No.27260) + 21]

3.5 NOTES

(1) In the case of setting that the origin of the workpiece coordinate system is on the table rotary axis
In the case that workpiece zero point offset value is set by the intention that the origin of the workpiece coordinate system is on the table rotary axis, the workpiece zero point offset should be changed because the setting value of center position of table rotary axis is changed by this function.

(2) Tool length compensation
Tool length compensation is not executed in this measurement cycle. This doesn't depend on the setting of bit 0 (CMPH) of the NC parameter No.27220.

3.6 RESTRICTIONS

(1) Unavailable functions
This measurement cycle cannot be used on the following MANUAL GUIDE i functions.
<1> NC program conversion function
<2> Input data check by simulation
<3> Simulation function (Animated, Tool path drawing)

3.7 ALARM AND MESSAGE

Number	Message	Description
MC3722	NOT MANAGE THIS CONST.	The rotary axis position calibration is executed in the following machine configuruation. - The mechanical unit type is not a table rotation type. This measurement cycle corresponds only to a table rotation type (parameter(No.19680)=12). - All rotary axes are a hypothetical axis. This measurement cycle corresponds only to a machine with normal rotary axis. (either parameter IA1 or IA2(No.19696#0,#1) is 0) - The axis direction of rotary axis is inclined. This measurement cycle corresponds only to a machine to which axis direction of rotary axis doesn’t incline. (parameter (No.19683, 19688)=0.0) - The attachment direction of the probe axis is not Z-axis direction. This measurement cycle corresponds only to a machine to which the attachment direction of the probe axis is Z-axis direction. (parameter (No.19697)=3 and parameter (No.19698, 19699)=0) - The rotary axis position used as the reference when the machine configuration is set is not the machine coordinates. This measurement cycle corresponds only to which the rotary axis position used as the reference when the machine configuration is set is setting of the machine coordinates. (parameter (No.19754#7)=1) - The axis name is as follows. (1) The axis name of X-axis of basic three axes is not “X”. (2) The axis name of Y-axis of basic three axes is not “Y”. (3) The axis name of Z-axis of basic three axes is not “Z”. (4) The axis name of rotary axis is not “A”, “B” or “C” Please review the parameter (No.1020).

Number	Message	Description
MC3723	COMMAND MODEIS WRONG	The condition of G code when the rotary axis position calibration is executed is wrong. Check the modal G code condition.
MC3726	FAILED TO CALCULATE	In the rotary axis position calibration, it became impossible to measure. Please refer to the measurement result list about details.

<Causes of the alarm (MC3726) >

"Cause ID of alarm (MC3726)" of the measurement result can identify the cause of the alarm (MC3726).

Refer to the following table.

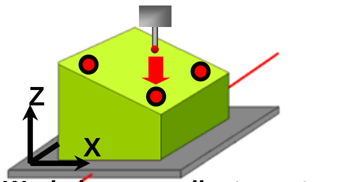
Cause ID of alarm (MC3726)			Cause
ID1	ID2	ID3	
G2890			
1	n	m	In measurement Pm of the center position of the datum sphere for the n-th rotary axis, the center position of the sphere can't be identified. This is because 4 points of spherical position are located on the same plane when the center position of the sphere is calculated. Modify the measurement position of the spherical position.
2	-	-	The diameter of the datum sphere is illegal. Set a correct value.
G2891			
1	n	-	In measurement of the center position of the datum sphere for the n-th rotary axis, angles of the rotary axis other than target measurement rotary axis are different in P1, P2 and P3. Set same angles.
2	n	-	In measurement of the rotary axis position for the n-th rotary axis, a center of the circle can't be identified. This is because 3 points of the center position of the datum sphere are located on the same line. Modify the measurement position of the center position of the datum sphere.
3	n	-	In measurement of the rotary axis position for the n-th rotary axis, the rotary axis position can't be identified. This is because the rotary axis position based on the measurement value is perpendicular to the rotary axis position based on the NC parameter. Check whether the rotary axis direction set in NC parameter (No.19682, 19687) is correct.

4 TILTED WORKING PLANE INDEXING COMMAND BY MEASURING

Tilted working plane indexing is executed by measuring three points on the tilted working plane, and the tool axis direction is made vertical for workpiece.

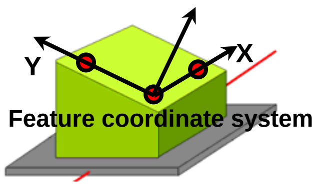
(Image of tilted working plane indexing command by measuring)

(1) The operator measures 3 points on titled working plane.



Workpiece coordinate system

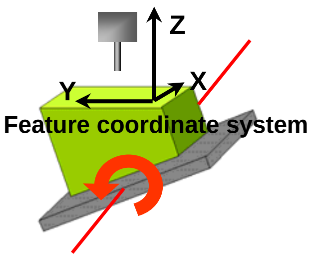
(2) The tilted working plane indexing command (G68.2) and incremental multiple command(G68.4) is outputted by the result of the measurement of 3 points. Then, feature coordinate system is set up on tilted working plane.



Output program

G68.2 I360. J0. K0.
G68.4 P2 Q1 "1st PT.MEASUREMENT START POSITION" : (workpiece coordinate)
G68.4 P2 Q2 "1st PT.MEASUREMENT START POSITION" : (workpiece coordinate)
G68.4 P2 Q3 "1st PT.MEASUREMENT START POSITION" : (workpiece coordinate)

(3) Tool axis direction control command (G53.1) is outputted automatically. Then, the tilted working plane become vertical to the tool.



Output program

G53.1

4.1 REQUIRED CONDITION FOR USING THIS FUNCTION

4.1.1 Required Model

The required model to use this function is as follows.

(1) FANUC Series 0*i*-MODEL F/0*i*-MODEL D
(2) FANUC Series 30*i*/31*i*/32*i*-MODEL A
(3) FANUC Series 30*i*/31*i*/32*i*-MODEL B

4.1.2 Required Machine System

The required machine system to use this function is as follows.

(1) "Tool rotation type machining center", which controlled by 2 axes of the tool
(2) "Table rotation type machining center", which controlled by 2 axes of the table
(3) "Composite type machining center", which controlled by 1 axes of the table and 1 axes of the tool

4.1.3 Required Option

Following option is necessary to use this function.

- FANUC Series 30*i*-MODEL A : Tilted working plane command with guidance (R522)
- FANUC Series 30*i*-MODEL B, 0*i*-MODEL F/ 0*i*-MODEL D : Tilted working plane indexing command (R522)

4.1.4 Required Software

Following software is necessary to use this function.

1. FANUC Series 0*i*-MODEL F/MODEL D

(1) CNC software

model	Series	version
0*i*-MF	D4G1	1.0 or later
0*i*-MD	D4F1	16.0 or later

(2) MANUAL GUIDE *i* software

model	Series	version
0*i*-MF	BX33	1.0 or later
0*i*-MD	BX32	12.0 or later
	BH32	5.0 or later

2. FANUC Series 30*i*/31*i*/32*i*-MODEL A

(1) CNC software

Model	series	version
30*i*-A	G002, G012, G022, G032	23.0 or later
	G003, G013, G023, G033	6.0 or later
	G004, G014, G024, G034	1.0 or later
31*i*-A	G101, G111	23.0 or later
	G103, G113	6.0 or later
	G104, G114	1.0 or later

Model	series	version
31*i*-A5	G121, G131	23.0 or later
	G123, G133	6.0 or later
	G124, G134	1.0 or later
32*i*-A	Not available	

(2) MANUAL GUIDE i software

Model	series	version
30*i*-A/31*i*-A/ 31*i*-A5	BY70	46.0 or later
	BY82 or BY83	33.0 or later
	BH11	33.0 or later
32*i*-A	Not available	

3. FANUC Series 30*i*/31*i*/32*i*-MODEL B

(1) CNC software
1.0 or later

(2) MANUAL GUIDE *i* software

model	series	version
30*i*-B/31*i*-B/ 32*i*-B5	BX71	5.0 or later
32*i*-B	Not available	

4.2 TILTED WORKING PLANE INDEXING BY MANUAL MEASURING

4.2.1 Operation Procedure

<Basic Operation>

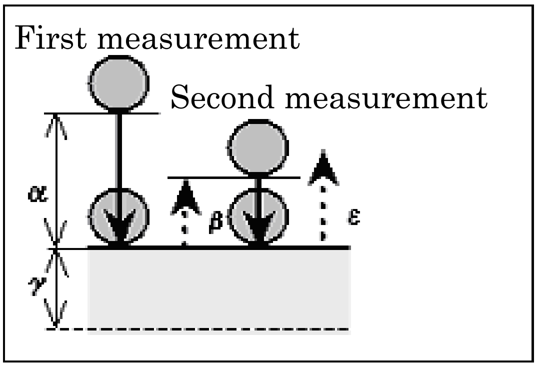
(1) press the [MEASURE] soft key, and the [MEASURE] screen is displayed.
(2) Select " TWP MEASUREMENT INDEXING " on the [WORK SET] tab, and The [TWPMEASUREMENT INDEXING] screen appears.
(3) By moving the probe manually, get it close to the measurement point where measurement is possible with the movement of the probe along the axis in one direction.
(4) After moving the probe, select a measurement direction from the soft keys and set up the measure condition.
(5) After entering "MEASURE DIRECTION," press, the [MESURE] soft key. The probe touches the measurement point automatically, and the current position of the measurement points displayed as the measurement result.
(6) Measure points from the 1st point to the 3rd point.
(7) Upon completion of measurement, select the [INDEX] tab by pressing the [→] cursor key. And the measurement result appears on the screen.
(8) After checking 3 point result, press the [CONFRM] soft key, then, the cursor is automatically moved to the input item “SAFE CHECK OF PROBE”.
(9) Move the probe to a safe position, and press the [CONFRM] soft key .
(10) press the [INDEX] soft key, then tilted working plane indexing is executed. At this time, the result of measurement is output to macro variables for the result of measurement. And the record is output to the measurement result list.

4.2.2 Measurement

The symbols used below have the following meanings

Symbol	Meaning
f1	Feed rate for 1st measurement
α	Approach distance for 1st measurement
β	Escaping distance for 1st measurement
γ	Overlap distance for measurement
f2	Feedrate for 2nd measurement
ε	Escaping distance for 2nd measurement

<Measurement in direction of –Z>



(1) Get the probe close to the measurement position by moving it manually.
(2) When measurement is started, the probe moves at a feedrate of f1 in the range (α+γ) from the current position to perform the first measurement cycle.
(3) Then, the probe returns through the distance β at the rapid traverse rate. Within the range (β+γ) from the current position, the probe moves at a feed rate of f2 to perform the second measurement cycle.
(4) After the second measurement cycle, the probe returns through the distance ε at the rapid traverse rate.
(5) The 2nd point and the 3rd point is measured as well as the measurement of the 1st point [step (1) through (4)].

4.3 TILTED WORKING PLANE INDEXING BY MEASURING CYCLE

4.3.1 Operation Procedure

<Basic Operation>

(1) In the EDIT mode, press the [MESCYC] soft key, and the [INSERT MEASUREMENT CYCLE] screen is displayed.
(2) Select " TWP MEASUREMENT INDEXING " on the [WORK SET] tab, and The [TWP MEASUREMENT INDEXING CYCLE] screen appears.
(3) Entering necessary data and press the [INSERT] soft key, then a G code program in the following format is stored in the machining program memory:

G2047 Q_ H_ V_ X_ A_ B_ R_ F_ ;

(4) Execute the stored program then, the measuring is executed.
(5) After the measurement, tilted working plane indexing is executed automatically. At this time, the result of measurement is output to macro variables for the result of measurement. And the record is output to the measurement result list.

<Detail of [MOTION] tab>

- MEASUREMENT COND. :
  Enter a measurement condition group number to be referenced at measurement time, by specifying a numeric value.
- 1ST MEAS.STRT PT.X :
  X coordinate of the measurement position of the first point (start position)
- 1ST MEAS.STRT PT.Y :
  Y coordinate of the measurement position of the first point (start position)
- 1ST MEAS.STRT PT.Z :
  Z coordinate of the measurement position of the first point (start position)
- 2ND DISTANCE :
  X coordinate distance from the first point to the second point(start position)
- 3RD DISTANCE :
  Y coordinate distance from the first point to the third point(start position)
- APROCH DISTANCE :
  Enter the move distance from the approach point to a measurement position in the Z-axis direction by specifying a numeric value.
- MOVING MEAS. SPEED :
  Enter a feedrate for measurement by specifying a numeric value.

4.3.2 Measurement Motion

The symbols used below have the following meanings

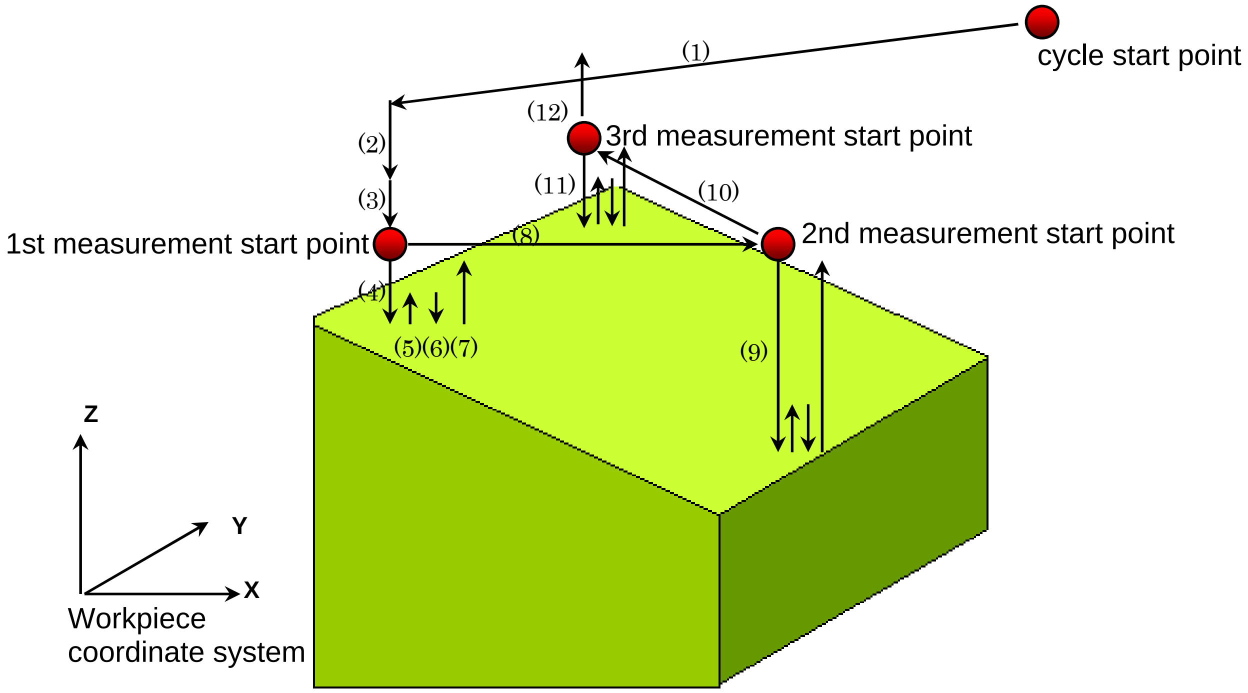
Symbol	Meaning
X1	X coordinate of the measurement position of the first point
Y1	Y coordinate of the measurement position of the first point
Z1	Z coordinate of the measurement position of the first point
X2	X coordinate distance from the first point to the second point
Y3	Y coordinate distance from the first point to the third point
f1	Feed rate for 1st measurement
α	Approach distance for 1st Measurement
β	Escaping distance for 1st Measurement
γ	Overlap distance for measurement
f2	Feedrate for 2nd measurement
ε	Escaping distance for 2nd Measurement

<Measurement in direction of –Z>

(1) The probe moves to the position (X1 and Y1), from the current position.(*1)
(2) The probe moves to Z1+α at the rapid traverse rate.
(3) The probe moves to Z1 at a feedrate of f1.
(4) Within the range (α+γ), the probe moves at a feedrate of f1 in the direction of –Z to perform the first measurement cycle.
(5) The probe returns through the distance β at the rapid traverse rate.(*2)
(6) Within the range (β +γ) from the current position, the probe moves at a feedrate of f2 to perform the second measurement cycle.
(7) The probe returns to Z1 at the rapid traverse rate.
(8) The probe moves to the position (X1+Y2) in the direction of X.
(9) The measurement of (4) – (7) is performed.
(10) The probe moves to X1 in the direction of X and moves to Y1+Y3 in the direction of Y.
(11) The measurement of (4) – (7) is performed.
(12) The probe moves to the position Z1+α in the direction of Z at the rapid traverse rate.(*3)

*1 The move speed follow the parameter No.12380#2
*2 In case of parameter No.27228#3=1, (5) (6) is not performed.
*3 In case of parameter No.27224#0=1, the probe moves to the start position of the measurement cycle in the direction of Z.

In case of parameter No.27224#0 = 0



4.4 CAUTIONS

4.4.1 Use of This Function During the Tilted Working Plane Indexing Command Mode

This function can not be used during the tilted working plane indexing command mode.

4.4.2 Use of This Function During 3-dimensional Coordinate System Conversion Mode

This function can not be used during 3-dimensional coordinate system conversion mode.

4.4.3 Use of This Function When There is a Phase Difference of the Rotation Axes of the Table

When there is a phase difference of the rotation axes of the table, this function can not be used.
However, if the tool length measurement is invalid, this function is available with no alarm.

4.4.4 Use of This Function During Tool Length Compensation

It is necessary to meet all the following requirements for using this function during tool length compensation mode.

1. A phase difference of the rotation axes of the table = 0.
2. Parameter No.27224#0=0
   (input item “approach distance” of measurement cycle is displayed.)
3. The parameter described bellow must be set.

<The parameter for using this function during tool length compensation mode>
Please refer to 4.5 "PARAMETER" for details of each parameter.

(1) No.3402#6 = 1
(2) No.3407#0 = 1
(3) No.3409#7 = 1
(4) No.5003#6 = 1
(5) No.5006#6 = 1
(6) No.14498
(7) No.6019#4 = 1
When it cannot be set as No.6019#4=1, it is necessary to set the PMC program and No.14498 so as to become 6019#4=1 temporarily during using this function.

4.5 PARAMETER

4.5.1 Required Parameter

This function is enabled when the following parameter is set.

(1) No.14856#0 = 0

	#7	#6	#5	#4	#3	#2	#1	#0
14856								**GID**

[Data type] Bit type
[Standard value] 00000000
[System attribute] Independent parameter between paths
[Power supply re-turning on] Unnecessary
GID 0 : The setup function is specified by the setup function option parameter.
1 : The setup function is disabled.

(2) No.12380#4 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
12380				**ATW**				

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary
ATW 0 : Tilted working plane indexing function is available.
1 : Tilted working plane indexing function is disable.

(3) No.11221#0 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
11221								**MTW**

[Data type] Bit type
[Standard value] 00000000
[System attribute] Independent parameter between paths
[Power supply re-turning on] Unnecessary
MTW 0 : Multiple commands of tilted working plane indexing are not used.
1 : Multiple commands of tilted working plane indexing are used.

(4) No.27253 = Arbitrariness

27253	**Start number of the macro variable area for workpiece to calculate Workpiece setting error amount, or for storage the argument of incremental multiple in tilted working plane indexing by measuring**

[Data type] Two word type
[Standard value] 0
[Valid data range] 10000 - 89999
[System attribute] Independent parameter between paths
[Power supply re-turning on] Unnecessary

(5) No.5400#2 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
5400						D3R		

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary

D3R When Reset is done by reset operation or reset signal from PMC, 3-dimensional coordinate system conversion mode, tilted working plane command mode and workpiece setting error compensation mode is
0 : canceled.
1 : not canceled.

<Required parameter for using this function during tool length compensation mode>

(6) No.3402#6 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
3402		CLR						

[Data type] Bit type
[Standard value] 00000000
[System attribute] Independent parameter between paths
[Power supply re-turning on] Unnecessary

CLR Reset button on the MDI panel, external reset signal, reset and rewind signal, and emergency stop signal
0 : cause reset state.
1 : cause clear state.

(7) No.3407#0 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
3407								C08

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary

C08 If bit 6 (CLR) of parameter No. 3402 is set to 1, set a group of G codes to be placed in the cleared state when the CNC is reset by the reset key of the MDI panel, the external reset signal, the reset and rewind signal, or the emergency stop signal
0 : places the G code group 08 in the cleared state.
1 : does not place G code group 08 in the cleared state.

(8) No.3409#7 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
3409								CFH

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary

CFH When bit 6 (CLR) of parameter No. 3402 is 1, the reset key on the MDI panel, the external reset signal, the reset and rewind signal, or emergency stop will
0 : clear F codes, H codes (for the M series), D codes (for the M series), and T codes (for the T series).
1 : not clear F codes, H codes (for the M series), D codes (for the M series), and T codes (for the T series).

(9) No.5003#6 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
5003		LVK						

[Data type] Bit type
[Standard value] 00000000
[System attribute] Independent parameter between paths
[Power supply re-turning on] Unnecessary

LVK Tool length compensation vector
0 : cleared by reset.
1 : not cleared, but held by reset.

(10) No.5006#6 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
5006		TOS						

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary

TOS Tool length compensation
0 : is performed by an axis movement.
1 : is performed by shifting the coordinate system.

(11) No.6019#4 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
6019				MSV				

[Data type] Bit type
[Standard value] 00000000
[System attribute] Independent parameter between paths
[Power supply re-turning on] Unnecessary

MSV When the tool length compensation offset of shifted type is used, Following system variables #5061 - #5080, #100151 - #100200 (Skip position)
0 : include tool length compensation offset or tool holder offset.
1 : do not include tool length compensation offset or tool holder offset.

(12) No.14498 = Arbitrary M code number

14498	Measuring start or end M code number of Tilted working plane indexing

[Data type] two word type
[Standard value] 0
[Valid data range] 0, 200 to 99999998
[System attribute] Independent parameter between paths
[Power supply re-turning on] Unnecessary

0	: M code is not output when measurement is executed.
Valid values other than 0	: M code of the value set by this parameter is output when measurement is executed.
Invalid values	: alarm is generated.

It is necessary to set this parameter so as to become 6019#4=1 temporarily during using this function. After setting this parameter, the machine tool builder should make PMC program so that the setting of parameter No.6019#4 is operated as follows.

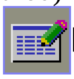
<Required PMC program>
- When M code of the value set by this parameter is output. : No.6019#4 = 1
- When M code of the value+1 set by this parameter is output. : No.6019#4 = 0
- When the reset operation is performed. : No.6019#4 = 0

5 MEASUREMENT SETTING SCREENS

5.1 SETTING MEASUREMENT CONDITIONS

A “measurement condition” identifies a measurement device system.
This procedure lets you set the conditions necessary for each type of measurement system.
Both measurement cycles and manual measurement reference the same settings.
Before starting measurement, be sure to set the necessary measurement conditions.

(Measurement condition setting screen selection method)

<1> Press the [>] soft key several times until the [SETING] softkey is displayed. Then press the [SETING] softkey on the base screen.

<2> The [SETTINGS] screen appears.

5.1.1 Setting of Measure Conditon

This procedure lets you set up measurement conditions.

<1> Place the cursor on "SETTING" on the [MEASURE COND] tab of the [SETTINGS] screen then press [OK]. The [SETTING OF MEASURE CONDITION] screen appears.

Input value setting range for each item

Specify each item, using a number.
The data entered on this screen is assigned to macro variables.

- GROUP NUMBER OF TOOL MEASURE CONDITION

Multiple groups of measurement conditions can be set so that those groups can be referenced in tool measurement and touch sensor calibration. Set a value greater than 1 in this item to change the measurement condition according to the type of tool used for measurement. Up to two groups can be set. Set 1 in this item to use only one measurement condition group.

- GROUP NUMBER OF WORK SET/MEASURE COND.

Multiple groups of measurement conditions can be set so that those groups can be referenced in centering, post-machining inspection, and probe calibration. Set a value greater than 1 in this item to change the measurement condition according to the type of probe used with a machine that allows the use of probes with different forms. Up to six groups can be set. Set 1 in this item to use only one measurement condition group.

- CUSTOMIZE ITEMS NUMBER

Set this item only when the machine tool builder uses this item for customization. Usually, set 0 in this item.

- COEFFICIENT FOR SETTING TOOL OFFSET

Set a ratio (%) for feeding back the result of measurement as a tool offset value in post-machining inspection. When 100 is set as this value, the result of measurement (that is, differential between the target value and measured value) is fed back as a tool offset value directly (×100%). When 0 is set, no value is fed back.

- HEIGHT OF PLANE PUT REFERENCE WORK

This item is referenced for stylus probe calibration measurement. Enter the machine coordinates of a plane where a reference workpiece is placed (such as the height of the top surface of a table).

5.1.2 Setting Measure Condition of Tool Measurement

The following procedure lets you set conditions for tool measurement. The same data can be set on the setting screen of each group.

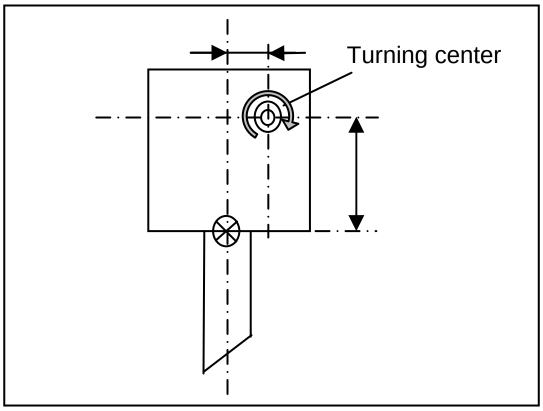
<1> Place the cursor on "TOOL MEASURE A" on the [MEASURE COND] tab of the [SETTINGS] screen then press [OK]. The [MEASURE CONDITION OF TOOL MEASUREMENT A] screen appears.

Input value setting range for each item

Specify each item, using a number.
The data entered on this screen is assigned to macro variables.

- X-/Y-DIFF. BASE POINT TO TOOL ATTACH POS.

"X-/Y-DIFF. BASE POINT TO TOOL ATTACH POS." is referenced for "TOUCH SENSOR POSITION MEASUREMENT" and "TOOL MEASUREMENT". If the base point of the coordinate system differs from the tool attachment position, enter the difference. Set this data, for example, if the head itself where a tool is attached has a turning function, and the turning axis is the base point of the coordinate system. Even in such a case, however, this data need not be set when the offset value from the base point of the coordinate system is used as the offset data of the tool.



NOTE
Enter a radius value also when using a CNC for lathes.

- Other setting items

Make settings related to measurement operation. For details, see Section 1.3, "TOOL MEASUREMENT," in Chapter 1, "MANUAL MEASUREMENT FUNCTIONS," or see Section 2.3, "TOOL MEASUREMENT (TOOL Z-AXIS DIRECTION)," in Chapter 2, "MEASUREMENT CYCLE."

NOTE
Enter a radius value for "APPROACH DISTANCE," "ESCAPING DISTANCE," and "OVERLAP DISTANCE" also when using the a CNC for lathes.

5.1.3 Setting Measure Condition of Work set/Measure

The following procedure lets you set measurement conditions related to centering and post-machining inspection. The same data can be set on the setting screen of each group.

<1> Place the cursor on "WORK SET/MEASURE A" on the [MEASURE COND] tab of the [SETTINGS] screen then press [OK]. The [MEASURE CONDITION OF WORK SET/MEASURE A] screen appears. This screen lets you set up conditions related to the movement of a tool in its radius direction.
<2> Press the [→] cursor key on this screen. The [AXIS DIRECT] tab appears. This screen lets you set up conditions related to the movement of a tool in its axis direction.
<3> Press the [→] cursor key again. The [C-AXIS DIREC] tab appears. This screen lets you set up conditions related to the movement of a tool in the C-axis direction.

Input value setting range for each item

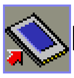
Specify each item, using a number.
The data entered on this screen is assigned to macro variables.

- Explanation of setting items

Make settings related to measurement operation. For details, see Section 1.4, "WORK SET," in Chapter 1, "MANUAL MEASUREMENT FUNCTIONS," or see Section 2.4, "WORK SET (PROBE Z-AXIS DIRECTION)," in Chapter 2, "MEASUREMENT CYCLE."

NOTE
Enter a radius value for "APPROACH DISTANCE," "ESCAPING DISTANCE," and "OVERLAP DISTANCE" also when using the a CNC for lathes.

5.1.4 Outputting Measurement Conditions to Memory Cards

When you press the [OUTPUT] soft key, the [YES] and [NO] soft keys are displayed to confirm your request for measurement data output.

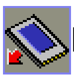
Pressing the [YES] soft key outputs the measurement condition data to a memory card.
Pressing the [NO] soft key cancels your output request and takes you back to the setting screen.

Output file name

The output file is named 'MEASCOND.DAT.'

5.1.5 Inputting Measurement Conditions from Memory Cards

Input screen

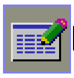
On the setting screen, press the [INPUT] soft key. The following file directory screen appears.

Pressing the [INPUT] soft key loads the selected measurement condition data file.
Pressing the [CLOSE] soft key closes the file directory, returning the screen display to the setting screen.

5.2 SETTING AND REFERENCING CALIBRATION DATA

This procedure lets you reference and set the calibration data necessary to perform each type of measurement.
Both measurement cycles and manual measurement reference and make the same settings.
Before starting measurement, be sure to set the necessary calibration data.

5.2.1 Selecting the Calibration Screen

<1> Press the [>] soft key several times until the [SETING] softkey is displayed. Then press the [SETING] softkey on the base screen.
<2> The [SETTINGS] screen appears.

5.2.2 Setting Calibration Data

The following procedure lets you make settings related to calibration data.

<1> Place the cursor on "SETTING" on the [CALIBRATION] tab of the [SETTINGS] screen then press [OK]. The [SETTING OF MEASURE CONDITION] screen appears.

Input value setting range for each item

Specify each item, using a number.
The data entered on this screen is assigned to macro variables.

- GROUP NUMBER OF TOOL MEASUR CALIBRATION

Multiple groups of touch sensor calibration data can be set so that those groups can be referenced in tool measurement. Set a value greater than 1 in this item to set calibration data for each touch sensor when using a machine that allows the use of several different touch sensors for tool measurement. Up to two groups can be set. Set 1 in this item to use only one calibration data group.

- WHETHER USE OF TOUCH SENSOR COMPENSATE

Set this item with a numeric value. Set 0 when specifying the position of a touch sensor for tool measurement with a reference value only. Set 1 when specifying the position of a touch sensor for tool measurement with a reference value plus a compensation value.

- GROUP NUM. OF WORK SET/MEASURE CALIB

Multiple groups of probe calibration data can be set so that those groups can be referenced in centering and post-machining inspection. Set a value greater than 1 in this item to set calibration data for each probe when using a machine that allows the use of several probes with different forms. Up to six groups can be set. Set 1 in this item to use only one calibration data group.

5.2.3 Referencing and Setting Touch Sensor Position Data

Touch sensor position data is referenced and set here. The result of measurement made in "Touch Sensor Position Measurement" is set here.
The same data can be set on the touch sensor position setting screen of each group.

<1> Place the cursor on "TOUCH SENSOR POSITION A" on the [CALIBRATION] tab of the [SETTINGS] screen then press [OK]. The [TOUCH SENSOR POSITION A] screen appears. The reference positions of the touch sensors are displayed here.

> **NOTE**
> The item "+X DIRECTION" represents the position of a sensor when measurements are made in the +X direction.

<2> Press the [→] cursor key. The [COMPENSATION] tab appears. On this screen, a compensation value for the reference position of each touch sensor is displayed. The sum of this compensation value and the coordinates of the the reference value is assumed to be the actual touch sensor position.

Input value setting range for each item

Specify each item, using a number.
The data entered on this screen is assigned to macro variables.

5.2.4 Referencing and Setting Probe Form Data

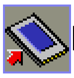
Probe form data is reference and set here. The results of measurement made in "Probe Length Measurement," "Stylus Ball Diameter Measurement," "Stylus Ball Center Offset Measurement-A," and "Stylus Ball Center Offset Measurement-B" are set here.
The same data can be set on the probe form setting screen of each group.

<1> Place the cursor on "PROBE FORM A" on the [CALIBRATION] tab of the [SETTINGS] screen then press [OK]. The [PROBE FORM A] screen appears.

Input value setting range for each item

Specify each item, using a number.
The data entered on this screen is assigned to macro variables.

5.2.5 Outputting Calibration Data to Memory Cards

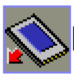
When you press the [OUTPUT] soft key on the setting screen, the [YES] and [NO] soft keys are displayed to confirm your request for measurement data output.

Pressing the [YES] soft key outputs the calibration data to a memory card.
Pressing the [NO] soft key cancels your output request and takes you back to the setting screen.

Output file name

The output file is named 'MEASCALB.DAT.'

5.2.6 Inputting Calibration Data from Memory Cards

On the setting screen, press the [INPUT] soft key. The following file directory screen appears.

Pressing the [INPUT] soft key loads the selected calibration data file.
Pressing the [CLOSE] soft key cancels the processing performed so far and closes the file directory. Then, the screen display returns to the setting screen.

5.3 SUPPORT FOR INCH/METRIC SWITCHING WITH THE SET-UP GUIDANCE FUNCTIONS

Inch/metric mode switching is supported for data handled with the set-up guidance functions. So, even when data set as metric data is entered, the data is automatically converted to inch data for display if the inch mode is set.

NOTE
The inch/metric switching function is an NC option function.

5.3.1 Data Display

Measurement condition data and calibration data is automatically converted for display according to the inch/metric mode setting.
Measurement condition data and calibration data is stored in macro variables for measurement. In this case, the data is stored as metric data. When such data is displayed on the setting screen, or is referenced for measurement macro execution, the data is converted to inch data when acquired if the inch mode is set.
Feedrate-related data is displayed as follows according to the inch/metric mode setting:

For metric display:
Data is displayed with all fractional digits discarded.
For inch display:
Data is displayed with two decimal places.

(Example) Feedrate for the first measurement time
For metric display: 300 [mm/min]
For inch display: 11.81 [inch/min]

The following data is not affected by the inch/metric input setting:

- Number of groups of measurement condition data for tool measurement/calibration data
- Number of groups of measurement condition data for centering and inspection after machining/calibration data
- Whether compensation values are available for calibration data for tool measurement
- Number of customization items
- Compensation values for the settings of tool compensation values for inspection after machining
- Measurement condition customization data

NOTE
Data in the C-axis (rotation axis) direction is not affected by the inch/metric setting. However, the decimal places of feedrate data are displayed according to the inch/metric setting.

5.3.2 Data Input/Output

Measurement condition data and calibration data is output to the memory card as described below.

Data output

Data is output as metric data.

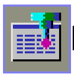
Data input

Data is input as metric data.
Data input as inch data is also stored in macro variables as metric data.

6 MEASUREMENT RESULT DISPLAY SCREENS

6.1 MEASUREMENT RESULT LIST SCREENS

6.1.1 Displaying the RESULT Screen

Press the  [MESLST] soft key in the manual or automatic operation mode. The"RESULT"screen is displayed.

6.1.2 Data Displayed on the RESULT Screen

Measurement date and time

The displayed measurement date and time data includes year, month, day, hour, minute, and second.

(Example) 2001 11/06 12:34:56

Measurement type

Whether the machine is in the automatic or manual mode is indicated along with the type of the measurement performed.

(Example) AUTO-OUTSIDE DIAMETER (MEASUREMENT PROBE Z-AXIS)

TARGET

The characters representing up to two axis addresses and the related numeric data are displayed.

- Results obtained when the machine is in the manual mode:
  The target used on the post-machining inspection menu is displayed.
  (Example) Circle outside diameter 'D 99999.999'

- Results obtained in automatic measurement:
  The target used on the post-machining inspection menu is displayed.
  (Example) Circle outside diameter 'D 99999.999'

  The reference coordinates used on the centering function menu are displayed.
  (Example) Circle center 'X -12345.678', 'Y-12345.678'

RESULT

The characters representing up to three axis addresses and the related numeric data are displayed.

(Example) Touch sensor position measurement 'X-12345.678', 'Y-12345.678', 'Z-12345.678'

JUDGE

Whether the measurement result was OK or NG and whether an offset value was changed are displayed only in automatic measurement.

SET DEST

- For measurements on the calibration menu:
  The name of a measurement condition group is displayed.

- For measurements on the centering function menu:
  The number for a workpiece coordinate system to be set up is displayed.

  (Example) Setting up G54.1P1 on a turning machine
  "T- G54.1P1"

- For measurements on the tool measurement and post-machining inspection menus:
  The tool offset number to be set is displayed.

  (Example)
  Setting offset number 100 for tool diameter and wear offset on a milling machine
  "M-D100-W"
  Setting offset number 25 for an X-axis geometry offset on a turning machine
  "T-X25-G"

SET DATA

The value to be set in SET DEST is displayed.
The characters representing up to three axis addresses and the related numeric data are displayed.

6.1.3 Clearing Measurement Result List Data

Pressing the [CLEAR] soft key on the measurement result list screen displays the confirmation message "Do you really want to delete all measurement results?" together with the [YES] and [NO] soft keys.
Pressing the [YES] soft key clears all measurement result list data from macro variables.

6.2 OUTPUTTING THE MEASUREMENT RESULT LIST TO A MEMORY CARD

6.2.1 Outputting Measurement Result List Data to A Memory Card

Pressing the [OUTPUT] soft key on the measurement result list screen displays the confirmation message "Do you really want to output the measurement result to a memory card?" together with the [YES] and [NO] soft keys.
Pressing the [YES] soft key outputs all the measurement result list data to a memory card under a file name of "MEASDATA.DAT."

6.2.2 Output Format

The data output to the memory card is in plain text format.
For easy incorporation into software such as spreadsheet software running on the personal computer, display items are delimited from each other by a comma (,) like "item,item,item,......" at data output time.

Example)
Output format

```
Date,Time,Auto/manual,Measurement
type,,Result,,,Target,,,Set destination,,Set data,,,Judge
2002/3/8,12:04:13,Automatic,Outside diameter,,,,,,,,,,,,,OK
,,,,,X,12345.678,,X,12345.678,,T-W57.1P1,,X,12345.678,,
,,,,,Y,12345.678,,Y,12345.678,,,,Y,12345.678,,
,,,,,Z,12345.678,,Z,12345.678,,,,Z,12345.678,,

2002/3/3,12:04:13,Manual,Touch sensor position,,,,,,,,,,,,,-
,,,,,X,12345.678,,,,,Type A,,,,,
,,,,,Y,12345.678,,,,,,,,,,
,,,,,Z,12345.678,,,,,,,,,,
```

Example of screen displayed when data is incorporated into spreadsheet software

Date	Time	Auto/manual	Measurement type		Result			Target			Set destination		Set data			Judge
2002/3/8	12:04:13	Automatic	Outside diameter													OK
					X	12345.678		X	12345.68		T-W57.1P1		X	12345.678		
					Y	12345.678		Y	12345.68				Y	12345.678		
					Z	12345.678		Z	12345.68				Z	12345.678		
2002/3/3	12:04:13	Manual	Touch sensor position													—
					X	12345.678					Type A					
					Y	12345.678										
					Z	12345.678										

7 OTHER FUNCTIONS

7.1 FUNCTION FOR SWITCHING THE MEASUREMENT MENU ACCORDING TO THE MACHINE CONFIGURATION

By setting the parameter for the set-up guidance functions, measurement items on the manual measurement and measurement cycle menu selection screens can be displayed or hidden. This function enables measurement menu display according to the machine configuration.

7.1.1 Hiding the Tool Measurement Cycle with the Tool Facing in the Z-Axis Direction

If bit 0 (TLZ) of parameter No. 27221 is set to 1, the measurement cycle with the tool facing in the Z-axis direction is not displayed on the tool measurement tab screen of the measurement cycle.

7.1.2 Hiding the Tool Measurement Cycle with the Tool Facing in the X-Axis Direction

If bit 1 (TLX) of parameter No. 27221 is set to 1, the measurement cycle with the tool facing in the X-axis direction is not displayed on the tool measurement tab screen of the measurement cycle.

7.1.3 Hiding the Workpiece Measurement Cycle with the Probe Facing in the Z-Axis Direction

If bit 2 (WRZ) of parameter No. 27221 is set to 1, "SINGLE SURFACE MEASUREMENT PROBE Z-AXIS" is not displayed on the manual measurement centering and post-machining inspection tab screens. Moreover, the measurement cycle in the probe Z-axis direction is not displayed on the measurement cycle menu selection screen.

7.1.4 Hiding the Workpiece Measurement Cycle with the Probe Facing in the X-Axis Direction

If bit 3 (WRX) of parameter No. 27221 is set to 1, "SINGLE SURFACE MEASUREMENT PROBE X-AXIS" is not displayed on the manual measurement centering and post-machining inspection tab screens. Moreover, the measurement cycle in the probe X-axis direction is not displayed on the measurement cycle menu selection screen.

7.1.5 Hiding the C-Axis Measurement Cycle

When bit 4 (CAX) of parameter No. 27221 is set to 1, the C-axis phase measurement is not displayed on the manual measurement menu selection screen and measurement cycle menu selection screen.

7.1.6 Hiding the Stylus Ball Center Offset Measurement Menu

When bit 5 (STA) of parameter No. 27225 is set to 1, Stylus Ball Center Offset Measurement-A is not displayed on the manual measurement and measurement cycle menu display screens. When bit 6 (STB) of parameter No. 27225 is set to 1, Stylus Ball Center Offset Measurement-B is not displayed.

NOTE

This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.

7.1.7 When a Lathe without the Y-Axis Is Used

When a lathe without the Y-axis is used, the input items related to Y-axis commands can be hidden by setting bit 7 (NOY) of parameter No. 27222 to 1.

Manual measurement

The input items related to Y-axis commands are not displayed. Moreover, the soft keys in the Y-axis direction are not displayed in connection with the input items involving measurement directions. When a measurement is made, no move command along the Y-axis is output.

NOTE

Even when the Y-axis is not used, the alphabetic character string indicating an input item displayed on the guide chart of each screen includes a character indicating Y-axis information.

Measurement cycle

The input items related to Y-axis commands are not displayed. Moreover, the soft keys in the Y-axis direction are not displayed in connection with the input items involving measurement directions. When a measurement is made, no move command along the Y-axis is output.

The measurement cycle menu selection screen does not display the items "Y-AXIS DIRECTION WORK SETUP" and "Y-AXIS DIRECTION MEASUREMENT."

Touch sensor position data reference and setting screen

When a setting is made for nonuse of the Y-axis, the touch sensor position setting screen does not display an item related to Y coordinate.

7.2 SAVING AND RESTORING MODAL INFORMATION

Modal information updated before execution of a measurement cycle or manual measurement can be restored after the execution of measurement to the state present before the execution of measurement.

NOTE

When bit 6 (MDL) of parameter No. 27223 is set to 1, modal information is neither saved nor restored.

7.2.1 Saving and Restoring Modal Information

The following modal information is restored:

<1> Feedrate F

<2> G code

G code	Group	Execution mode
G90 / G91	03	Milling
G00 / G01 / G02 / G03	01	Milling / Lathe
G60	01(Depends on the parameter.)	Milling / Lathe
G98 / G99 (G94 / G95)	05	Lathe

If a measurement cycle is executed in any of the following modes, an alarm is issued:

Turning mode

G code	Group	G code system	Remark
G32	01	A	
G33	01	B,C	
G34	01	A,B,C	
G35	01	A,B,C	
G36	01	A,B,C	Depends on the parameter.
G71	01	A,B	Depends on the parameter.
G72	01	A,B,C	Depends on the parameter.
G73	01	A,B,C	Depends on the parameter.
G74	01	A,B,C	Depends on the parameter.
G75	01	C	Depends on the parameter.
G90	01	A	
G92	01	A	
G94	01	A	
G77	01	B	
G78	01	B	
G79	01	B	
G20	01	C	
G21	01	C	
G24	01	C	

Milling mode

G code	Group
G2.2	01
G3.2	01
G2.3	01
G2.3	01
G2.4	01
G3.4	01
G6.2	01
G33	01
G75	01
G77	01
G78	01
G79	01
G81.1	01

7.2.2 Approach Distance Specification at Measurement Time

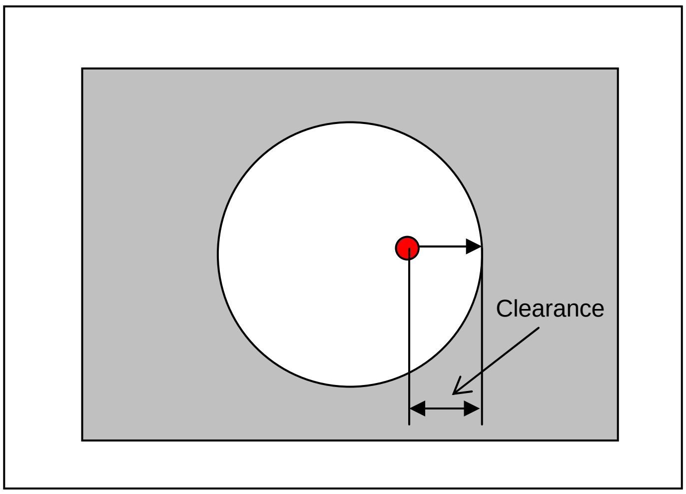
When the set-up guidance functions are used, APPROACH DISTANCE FOR 1ST MEASUREMENT is used as a move distance for the first measurement in either manual measurement execution or cycle execution.
In an actual manual measurement, the probe is positioned at a proper location for measurement. So, a relatively large approach distance may be set to protect against the alarm for the no-contact of the probe. In a measurement cycle, however, a relatively small approach distance may be set to consume less measurement cycle operation time or to ensure that, in a measurement of the inside diameter of a circle, the approach position is not outside of the circle. Thus, it is difficult to set a proper value for both of a manual measurement and measurement cycle in some cases.
When this function is enabled, the measurement condition setting screen newly displays the setting item CLEARANCE DISTANCE FOR MEASUR CYCLE, and the value set here is used for approach operation in a measurement cycle. In a manual measurement, APPROACH DISTANCE FOR 1ST MEASUREMENT is used as in the case where this function is disabled. This means that a different move distance for the first measurement can be specified in each of measurement cycle execution and manual measurement execution.

NOTE
1 This function cannot be used with the FANUC Series 16*i*/18*i*-TB CNC for compound machining function.
2 This function is enabled when bit 5 of parameter No. 27223 is set to 1.

Setting screen
When bit 5 of parameter No. 27223 is set to 1, the measurement condition setting screen displays the setting item CLEARANCE DISTANCE FOR MEASUR CYCLE.

Measurement motion
When bit 5 of parameter No. 27223 is set to 1, the value set in CLEARANCE DISTANCE FOR MEASUR CYCLE is used as a move distance for the first measurement in measurement cycle execution.

[Example]
When a measurement cycle for measurement of the inside diameter of a circle on the XY plane is executed



<1> A rapid movement is made from the current position to the point specified by ("CENTER POINT X"+("INSIDE DIAMETER"/2-"CLEARANCE DISTANCE FOR MEASUR CYCLE"-"stylus ball radius")) in the X-axis direction and by "CENTER POINT Y" in the Y-axis direction.

<2> A rapid movement is made in the Z-axis direction to the approach point ("HEIGHT OF MEAS.PT."+"APROCH DISTANCE").
<3> A movement is made in the -Z-axis direction to the position specified by "HEIGHT OF MEAS.PT." at "FEED-RATE FOR APPROACHING START POINT" in the axis direction.
<4> The first measurement is made in the range ("CLEARANCE DISTANCE FOR MEASUR CYCLE"+"OVERLAP DISTANCE FOR MEASUREMENT") at "FEED-RATE FOR 1ST MEASUREMENT."

Manual measurement operation remains unchanged.

P-CODE macro variables used

Measurement condition setting data is preserved in the P-CODE macro variables starting with "measurement condition variable start number" specified in parameter No. 12381.

When this function is enabled (when bit 5 of parameter No. 27223 is set to 1) and the following is set on the measurement condition operation setting screen, modify the setting of the parameter for specifying the P-CODE macro variable number for measurement:

GROUP NUMBER OF TOOL MEASURE CONDITION	2
GROUP NUMBER OF WORK SET/MEASURE COND.	6
CUSTOMIZE ITEMS NUMBER	20

12381	**Measurement condition variable start number**

(Default value = 10000)

12382	**Calibration variable start number**

(Default value = 10200)

12383	**Measurement execution variable start number**

(Default value = 10320)

12384	**Measurement result storage variable start number**

(Default value = 10600)

12385	**Number of variables for storing measurement results**

(Default value = 699)

⚠ CAUTION

Before modifying the values set in parameter No. 12381 through No. 12385, output the measurement condition data and calibration data to a memory card. After the parameters are modified, the output measurement condition data and calibration data can be restored by inputting the output data from the memory card.

7.3 SUPPORTING TOOL MANAGEMENT

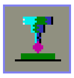
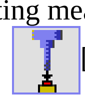
When the tool management option is available, it is possible to specify the item to which a tool offset value measured in manual or automatic measurements (measurement cycles) is to be set, using OFFSET TYPE.

> **NOTE**
> The tool management function supported by this function manages each tool by using a "tool number" unique to MANUAL GUIDE *i*. For details, refer to "Tool Management Function" in "MANUAL GUIDE *i* OPERATOR'S MANUAL (B-63874EN)."

7.3.1 TOOL MEASUREMENT (MANUAL MEASUREMENT)

When a tool measurement result is fed back to a tool offset value, specifying either of the following items enables the measurement result to be fed back.
- Offset number
- Offset type

7.3.1.1 Selecting the TOOL MEASUREMENT Screen

<1> Press the [MESURE] soft key on the base screen in the manual operation mode. The measurement menu screen for selecting measurement type is displayed.
<2> On the "TOOL MESUR" tab, select [TOOL MEASUREMENT].

7.3.1.2 Displays on the Screen

[T-SELECT] tab

The tool number corresponding to the current spindle position is displayed on the guide chart.
Specify "GROUP NO." and press the [TL-SEL] soft key. The tool is exchanged, and the tool number of the newly selected tool is displayed.

- TOOL NO.
The function of this item is the same as when tool management is disabled.

- GROUP NO.
This item lets you specify the group number (tool type number) for a tool to be selected, using a number.

> **NOTE**
> This item is not displayed if the MSR parameter (bit 2 of parameter No. 14823) is '0'.

- Soft key descriptions

[TL-SEL]
This soft key lets you exchange the tool according to a specified "TOOL NO." or "GROUP NO."

> **NOTE**
> An alarm is issued if "TOOL NO." and "GROUP NO." are specified at the same time.

The functions of the other soft keys are the same as when tool management is disabled.

[MEASURE] tab

This screen is used to execute a measurement. This screen is the same screen as used when the tool management function is not enabled.

[T-TOOL] tab

This screen is used to set the result of measurement.

> **NOTE**
> With the CNC for a machining center, the [T-TOOL] tab is not displayed.

Entering "TOOL OFFSET NO." causes the corresponding data to be displayed.
Entering "OFFSET TYPE" causes a tool offset number to be calculate from the tool number and tool type and displays the offset value for the obtained tool offset number.

- TOOL OFFSET NO. T-SIDE

The function of this item is the same as when tool management is disabled.

- OFFSET TYPE

This item lets you specify the offset type for which the measured offset value is to be set.
Data set range: 1 to the number of offset types specified in parameter No. 14825

> **NOTE**
> This item is not displayed if the MSR parameter (bit 2 of parameter No. 14823) is '0'.

- OFFSET KIND

The function of this item is the same as when tool management is disabled.

- Soft key descriptions

[SET]

This soft key lets you set the measured tool offset value in "OFFSET NO." or "OFFSET TYPE."

> **NOTE**
> An alarm is issued if "OFFSET NO." and "OFFSET TYPE" are specified at the same time.

[OFFSET]

This soft key lets you display the tool offset screen.

The functions of the other soft keys are the same as when tool management is disabled.

[M-TOOL] tab

This screen is used to set the result of measurement.
The function of this screen is the same as for "Measurement result set screen (T-TOOL)."

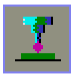
NOTE
With the CNC for a lathe, the [M-TOOL] tab is not displayed.

7.3.2 MEASURE (MANUAL MEASUREMENT)

When a workpiece measurement result is fed back to a tool offset value, specifying one of the following items enables the measurement result to be fed back to the tool offset value.

- Offset number
- Tool number and offset type
- Group number (tool type number) and offset type

7.3.2.1 Selecting the MEASURE Screen

<1> Press the  [MESURE] soft key on the base screen in the manual operation mode. The measurement menu screen for selecting measurement type is displayed.
<2> On the "MEASURE" tab, select a post-machining inspection type.

7.3.2.2 Displays on the Screen

[MEASURE] tab

The function of this screen is the same as when tool management is disabled.

[T-TOOL] tab

This screen is used to set the result of measurement.

NOTE
With the CNC for a machining center, the [T-TOOL] tab is not displayed.

Entering "TOOL OFFSET NO." causes the corresponding data to be displayed.
Entering "OFFSET TYPE" causes a tool offset number to be calculate from the tool number and tool type or from the group number and offset type, and displays the offset value for the obtained tool offset number.

NOTE
1 If "OFFSET TYPE" is specified, either "TOOL NO." or "GROUP NO." must be specified.
2 If "OFFSET NO." and "OFFSET TYPE" are specified at the same time, the "OFFSET NO." data rather than the "OFFSET TYPE" data is displayed.
3 If "OFFSET NO.," "GROUP NO.," and "OFFSET TYPE" are specified at the same time, the offset value data calculated from the "OFFSET TYPE" corresponding to the "TOOL NO." rather than the other type of data is displayed.

- TOOL OFFSET NO. T-SIDE

The function of this item is the same as when tool management is disabled.

- TOOL NO.

This item lets you specify the tool number for a tool for which the measured offset value is to be set.

- GROUP NO.

This item lets you specify the group number (tool type number) for a tool for which the measured offset value is to be set.

- OFFSET TYPE

This item lets you specify the offset type for which the measured offset value is to be set.
Data set range: 1 to the number of offset types specified in parameter No. 14825

> **NOTE**
> None of "TOOL NO.," "GROUP NO., " and "OFFSET TYPE" is displayed if the MSR parameter (bit 2 of parameter No. 14823) is '0'.

- OFFSET KIND

The function of this item is the same as when tool management is disabled.

Soft key descriptions

[SET]
This soft key lets you set the measured tool offset value for the specified "OFFSET NO." or "OFFSET TYPE."

[OFFSET]
This soft key lets you display the tool offset screen.

The functions of the other soft keys are the same as when tool management is disabled.

[M-TOOL] tab

This screen is used to set the result of measurement.

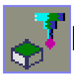
> **NOTE**
> With the CNC for a lathe, the [M-TOOL] screen is not displayed.

7.3.3 TOOL MEASUREMENT (AUTOMATIC MEASUREMENT)

When a workpiece measurement result is fed back to a toll offset value, specifying either of the following items enables the measurement result to be fed back. If an offset type is specified, the offset value corresponding to the tool number of the tool placed at the spindle position when a measurement is made is changed.

- Offset number
- Offset type

7.3.3.1 Selecting the TOOL MEASUREMENT Screen

<1> Press the  [MESCYC] soft key on the base screen in the edit mode. The measurement cycle menu screen for selecting measurement type is displayed.

<2> On the "TOOL MESUR" tab, select a tool measurement type.

7.3.3.2 Displays on the Screen

[MOTION] tab
The function of this screen is the same as when tool management is disabled.

[T-TOOL] tab
This screen is the input screen (for turning) used for automatic tool offset setting.

> **NOTE**
> With the CNC for a machining center, the [T-TOOL] tab is not displayed.

- COMP. NUMBER T
The function of this item is the same as when tool management is disabled.

- OFFSET TYPE
This item lets you specify the offset type for which the measured offset value is to be set.

> **NOTE**
> When bit 2 (MSR) of parameter No. 14823 is set to 0, this item is not displayed.

[M-TOOL] tab
This screen is the input screen (for milling) used for automatic tool offset setting.
The contents of this screen are the same as for "Input screen for automatic tool offset setting (turning machine)."

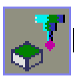
> **NOTE**
> With the CNC for a lathe, the [M-TOOL] tab is not displayed.

7.3.4 MEASURE (AUTOMATIC MEASUREMENT)

When a workpiece measurement result is fed back to a tool offset value, specifying one of the following items enables the measurement result to be fed back to the tool offset value.

- Offset number
- Tool number and offset type
- Group number (tool type number) and offset type

7.3.4.1 Selecting the MEASURE Screen

<1> Press the  [MESCYC] soft key on the base screen in the edit mode. The measurement cycle menu screen for selecting measurement type is displayed.
<2> On the "MEASURE" tab, select a post-machining inspection type.

7.3.4.2 Displays on the Screen

[MOTION] tab
The function of this screen is the same as when tool management is disabled.

[T-TOOL] tab
This screen is the input screen (for turning) used for automatic tool offset setting.

NOTE
With the CNC for a machining center, the [T-TOOL] tab is not displayed.

- COMP. NUMBER T
The function of this item is the same as when tool management is disabled.

- TOOL NUMBER
This item lets you specify the tool number for a tool for which the measured offset value is to be set.

- GROUP NUMBER
This item lets you specify the group number (tool type number) for a tool for which the measured offset value is to be set.

- OFFSET TYPE
This item lets you specify the offset type for which the measured offset value is to be set.

- SETTING DEST. (T)
The function of this item is the same as when tool management is disabled.

NOTE
When bit 2 (MSR) of parameter No. 14823 is set to 0, the items "TOOL NUMBER", "GROUP NUMBER", and "OFFSET TYPE" are not displayed.

[M-TOOL] tab
This screen is the input screen (for milling) used for automatic tool offset setting.
The contents of this screen are the same as for "Input screen for automatic tool offset setting (turning machine)."

NOTE
With the CNC for a lathe, the [M-TOOL] tab is not displayed.

7.4 FUNCTIONS USABLE WITH A MULTIPATH LATHE

The set-up guidance functions can also be used with a multipath system.

> **NOTE**
> When using the manual measurement function, be sure to set the following parameter to 1:
> Parameter SPT(No.27400#0)
> =0 A soft key is used to switch the display path.
> =1 A tool post selection signal is used to switch the display path.
> (Reason)
> On the manual measurement screen, operations such as a manual feed operation are performed during screen display. Usually, a path for performing such an operation is controlled by a tool post selection signal. However, if the MANUAL GUIDE *i* screens do not interact with a tool post selection screen, screen display information differs from an actual measurement operation, resulting in an incorrect measurement.

7.4.1 Manual Measurement Function

When a measurement is made on a manual measurement screen, the measurement is executed with the path selected at that time. Measured data is also fed back to the calibration data, workpiece coordinate system offset, and tool offset of the path selected at that time.

7.4.2 Measurement Cycle Function

Measured data is fed back to the calibration data, workpiece coordinate system offset, and tool offset of the path selected at that time.

7.4.3 Setting Screen

Measurement condition data and calibration data are set on a path-by-path basis. Each setting screen displays the measurement condition data and calibration data of the selected path.

7.4.4 Measurement Result List Screen

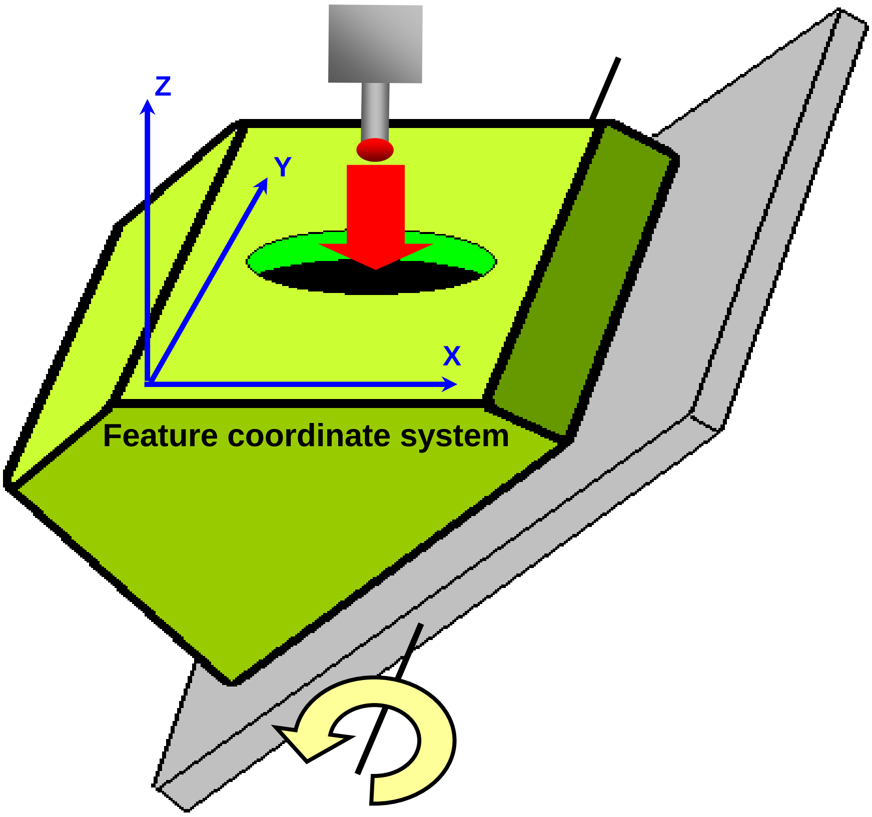
The measurement result list screen displays the results of measurements made with the selected path.

7.4.5 Tool Management Function

In a multipath system, tool management data is common to all paths. Cartridge management data is also common. Spindle position data and standby position data exist for each path.

7.5 SET-UP GUIDANCE FUNCTIONS IN TILTED WORKING PLANE COMMAND MODE

Set-up guidance functions of MANUAL GUIDE *i* can be used in the tilted working plane command mode.



> **NOTE**
> Following option is necessary to use this function.
> - FANUC Series 30i-MODEL A : Tilted working plane command with guidance (R522)
> - FANUC Series 30i-MODEL B, 0i-MODEL F/0i-MODEL D : Tilted working plane indexing command (R522)

NOTE

Following software is necessary to use this function.

(1) MANUAL GUIDE *i* software

1.FANUC Series 30i-MODEL A

- Control software	A02B-0303-J551#BY70 version 45.0 or later
- Definition file software	A02B-0303-J551(#BY82 or #BY83) version 45.0 or later
- Optional software (For milling machine)	A02T-0303-J552#BJ11 version 31.0 or later

2.FANUC Series 30i-MODEL B

- Control software,Definition file software,Optional software (For milling machine) A02B-0323-J560#BX71 version 5.0 or later

3.FANUC Series 0i-MODEL D

- Control software	A02B-0319-H540#BX32 version 14.0 or later
- Definition file software	A02B-0319-J553#BX32, A02B-0319-J554#BX32, A02B-0319-J555#BX32, A02B-0319-J556#BX32, A02B-0319-J557#BX32 version 14.0 or later
- Optional software (For milling machine)	A02B-0320-J552#BJ32 version 7.0 or later

4.FANUC Series 0i-MODEL F

- Control software,Definition file software,Optional software (For milling machine) A02B-0339-H540#BX33 version 1.0 or later

(2) CNC software

- FANUC Series 30i-MODEL A	G004, G014, G024, G034	version 6.0 or later
- FANUC Series 31i-MODEL A	G104, G114	version 6.0 or later
- FANUC Series 31i-MODEL A5	G124, G134	version 6.0 or later
- FANUC Series 30i-MODEL B	G301, G311, G321, G331	first version or later
- FANUC Series 31i-MODEL B	G401, G411	first version or later
- FANUC Series 31i-MODEL B5	G421, G431	first version or later
- FANUC Series 0i-MODEL D	D4F1	version 16.0 or later
- FANUC Series 0i-MODEL F	D4G1	version 1.0 or later

7.5.1 Usable Measurement Function in Tilted Working Plane Command Mode

The following measurement functions can be used.

1. Manual measurement function
   (1) Work set
   (2) Measure

2. Measurement cycle function
   (1) Work set
   (2) Measure

NOTE
- “C-AXIS PHASE MEASUREMENT” cannot be used in the tilted working plane command mode.
- The measurement of “WORKPIECE ROTATION TYPE” cannot be used in the tilted working plane command mode.
- “WORK SETTING ERROR MEASUREMENT” cannot be used in tilted working plane command mode.

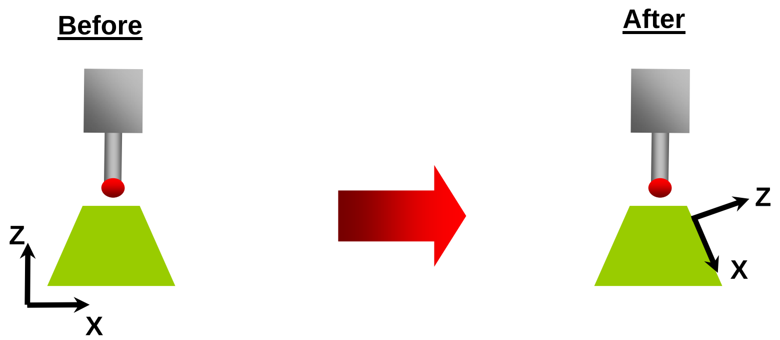
7.5.2 Work Set of Manual Measurement Function

Work set of manual measurement function can be used in the tilted working plane command mode. The measurement result isn’t set to a workpiece coordinate system. Instead, a feature coordinate system is shifted by outputting incremental multiple command.

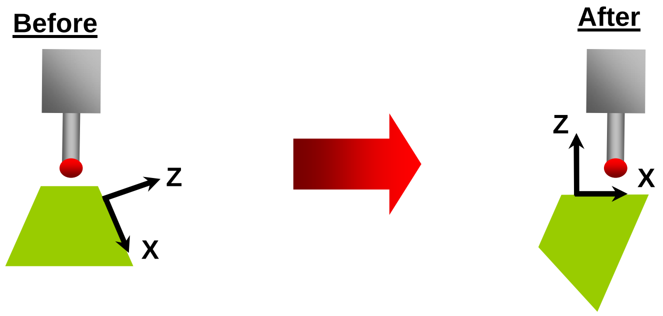
7.5.2.1 Single surface measurement probe z-axis

1. Input items
“WORK COORDINATE NO. M” isn’t displayed.
The other input items are same with the case that tilted working plane command mode is disabled.

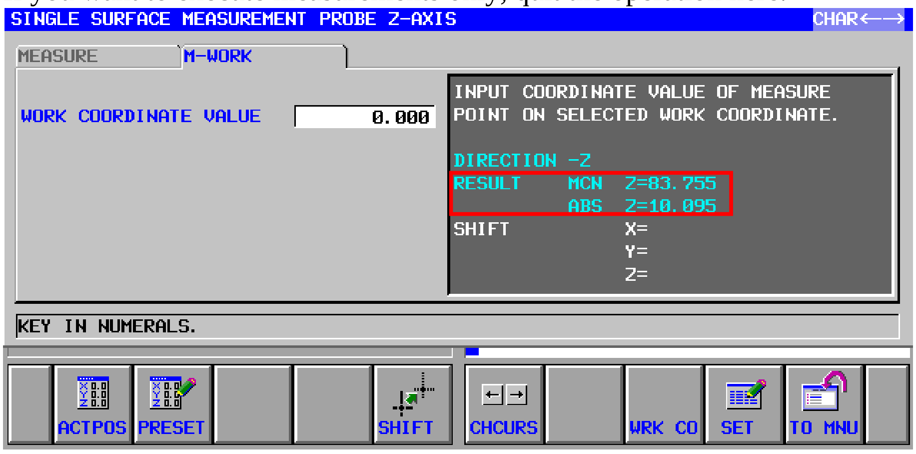
2. Measurement procedure
(1) Execute tilted working plane command G68.2 by MDI mode or MEM mode before manual measurement is executed. Then, a feature coordinate system is set on the tilted working plane.



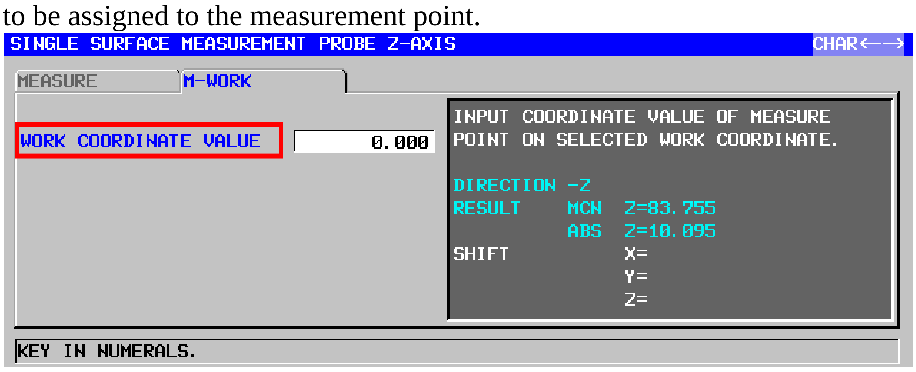
(2) Execute tool axis direction control command G53.1.
Then, the probe is turned perpendicular to the tilted working plane.



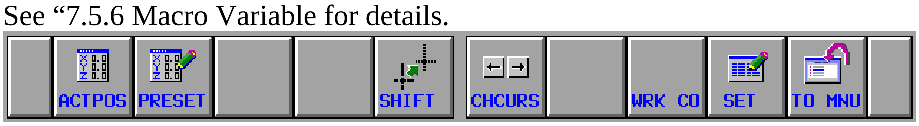
(3) Executed tool length compensation.
Then, programmed point operates to be the probe tip position.
(4) Select "SINGLE SURFACE MEASUREMENT PROBE Z-AXIS" in the "WORK SET" tab of manual measurement menu screen.
(5) Measurement execution procedure is same with the case that tilted working plane command mode is disabled. Select the direction in a feature coordinate system about "MEASURE DIRECTION".
(6) After a measurement, select the "M-WORK" tab by pressing the [→] cursor key.
(7) The measurement result appears on the screen.
Absolute coordinate value of the measurement result is displayed in a feature coordinate system.
If you want to execute measurements only, quit the operation here.



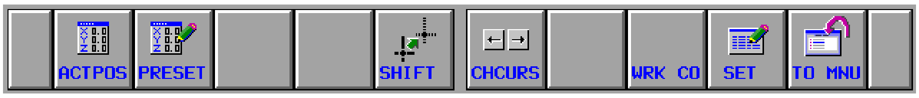
(8) In "WORK COORDINATE VALUE" specify what coordinates in the feature coordinate system are to be assigned to the measurement point.



(9) Press the [SET] soft key, a difference between the measurement result and input value of "WORK COORDINATE VALUE" is set to the macro variables specified by parameter No.27259.
See "7.5.6 Macro Variable for details.



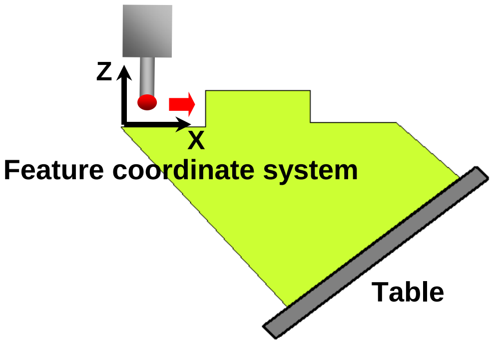
(10) Press the [SHIFT] soft key, then a feature coordinate system is shifted by outputting incremental multiple command G68.4. However, if procedure of (9) isn't executed, a feature coordinate system isn't shifted.



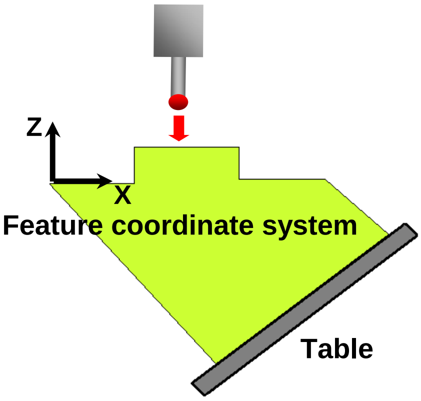
<Measurement procedure of plural direction>

After plural direction measurement, a feature coordinate system can be shifted.
The measurement procedure of two measurement directions is described as follows.

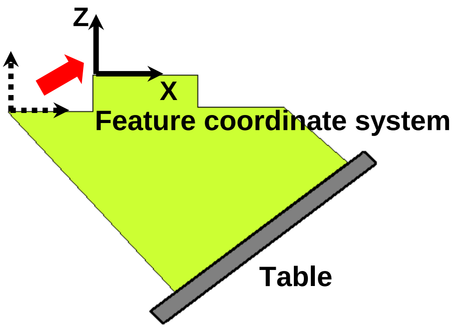
(1) Execute the first measurement.
(Execute "2. Measurement procedure" from (1) to (9).)



(2) Execute the second measurement into the different direction from the first measurement.
(Execute "2. Measurement procedure" from (5) to (9).)



(3) After the measurement, a feature coordinate system is shifted by pressing [SHIFT] soft key.



3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.2.2 Single surface measurement probe x-axis

1. Input items

Input items are same with the case of “Single Surface Measurement Probe Z-axis”.

2. Measurement procedure

This procedure is similar with the case of “Single Surface Measurement Probe Z-axis”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

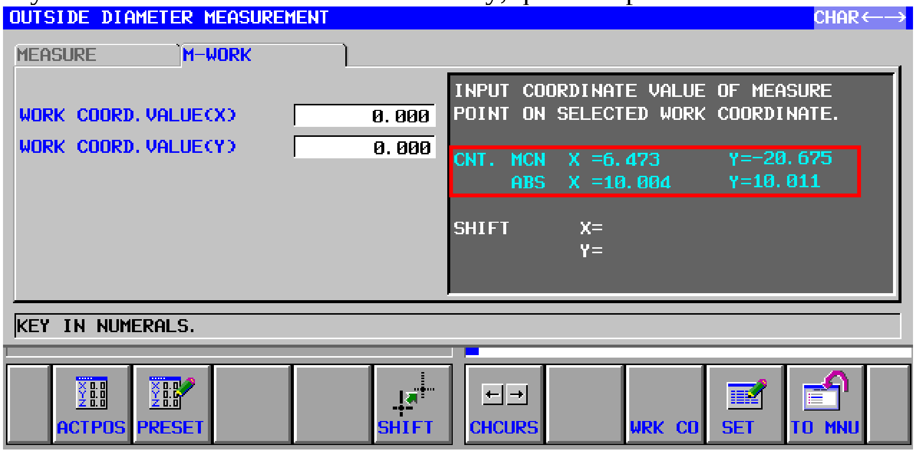
7.5.2.3 Outside diameter measurement

1. Input items

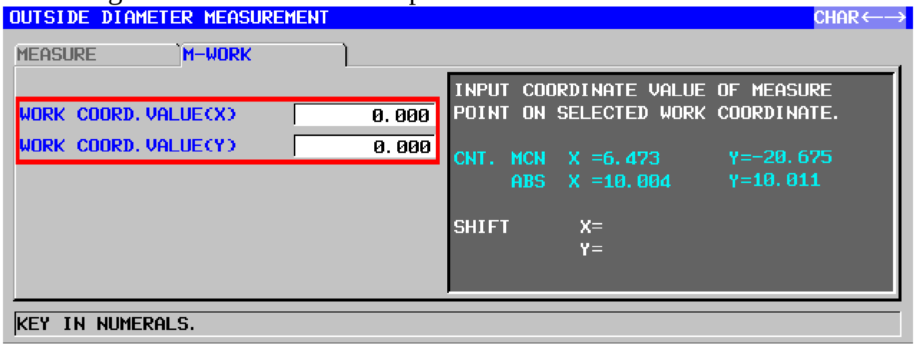
“WORK COORDINATE NO. M” isn’t displayed.
The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure

(1) Executed measurement procedure from (1) to (3) of “7.5.2.1 Single surface measurement probe z-axis” before manual measurement.
(2) Select ”OUTSIDE DIAMETER WORK SETUP” in the “WORK SET” tab of manual measurement menu screen.
(3) Measurement execution procedure is same with the case that tilted working plane command mode isdisabled. Select the plane and direction in a feature coordinate system about ”MEASURE PLANE” and “MEASURE DIRECTION”.
(4) After measuring the fourth point, select the “M-WORK” tab by pressing the [→] cursor key.
(5) Based on the measurement results on the four points, the center position is displayed on the screen. Absolute coordinate value of the measurement result is displayed in a feature coordinate system.
If you want to execute measurements only, quit the operation here.



(6) In “WORK COORDINATE VALUE” specify what coordinates in a feature coordinate system are to be assigned to the measurement point.



(7) Press the [SET] soft key, a difference between the measurement result and input value of “WORK COORDINATE VALUE” is set to the macro variables specified by parameter No.27259.
See “7.5.6 Macro Variable” for details.

(8) Press the [SHIFT] soft key, then a feature coordinate system is shifted by outputting incremental multiple command G68.4. However, if procedure of (7) isn’t executed, a feature coordinate system isn’t shifted.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.2.4 Inside diameter measurement

1. Input items

Input items are same with the case of ”Outside Diameter Measurement”.

2. Measurement procedure

This procedure is similar with the case of ”Outside Diameter Measurement”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

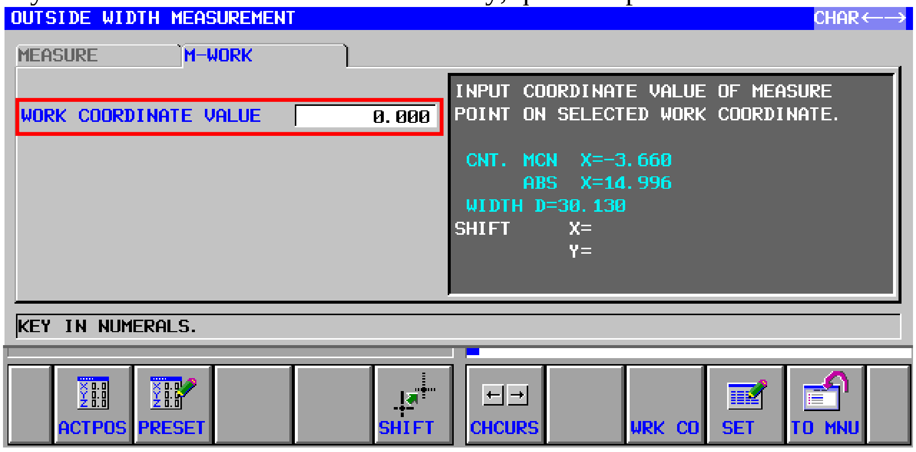
7.5.2.5 Outside width measurement

1. Input items

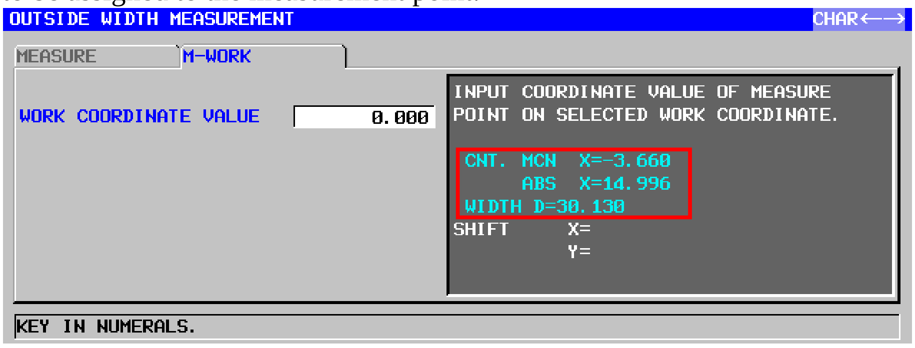
"WORK COORDINATE NO.M" isn't displayed.
The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure

(1) Executed measurement procedure from (1) to (3) of "7.5.2.1 Single surface measurement probe z-axis" before manual measurement.
(2) Selected "OUTSIDE WIDTH WORK SETUP" in the "WORK SET" tab of manual measurement menu screen.
(3) Measurement execution procedure is same with the case that tilted working plane command mode is disabled. Select the direction in a feature coordinate system about "MEASURE DIRECTION".
(4) After a measurement, select the "M-WORK" tab by pressing the [→] cursor key.
(5) Based on the measurement results on the two points, the center position and width are displayed on the screen.
Absolute coordinate value of the measurement result is displayed in a feature coordinate system.
If you want to execute measurements only, quit the operation here.



(6) In "WORK COORDINATE VALUE" specify what coordinates in the feature coordinate system are to be assigned to the measurement point.

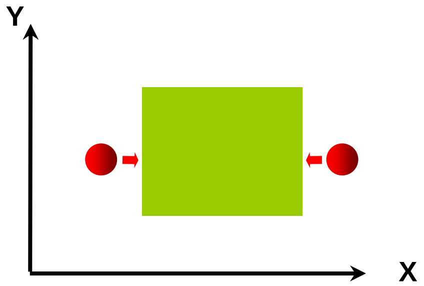


(7) Press the [SET] soft key, a difference between the measurement result and input value of "WORK COORDINATE VALUE" is set to the macro variables specified by parameter No.27259.
See "7.5.6 Macro Variable" for details.
(8) Press the [SHIFT] soft key, then a feature coordinate system is shifted by outputting incremental multiple command G68.4. However, if procedure of (7) isn't executed, a feature coordinate system isn't shifted.

<Measurement procedure of plural direction>

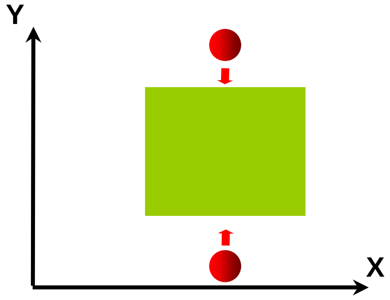
After plural direction measurement, a feature coordinate system can be shifted.
The measurement procedure of two measurement directions is described as follows.

(1) Execute the first measurement.
(Execute “2. Measurement procedure” from (1) to (7).)



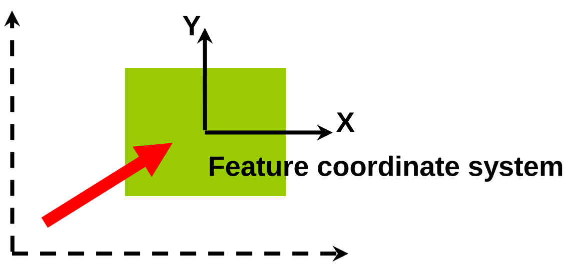
Feature coordinate system

(2) Execute the second measurement into the different direction from the first measurement.
(Execute “2. Measurement procedure” from (2) to (7).)



Feature coordinate system

(3) After the measurement, a feature coordinate system is shifted by pressing [SHIFT] soft key.



3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.2.6 Inside width measurement

1. Input items

Input items are same with the case of “Outside Width Measurement”.

2. Measurement procedure

This procedure is similar with the case of “Outside Width Measurement”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

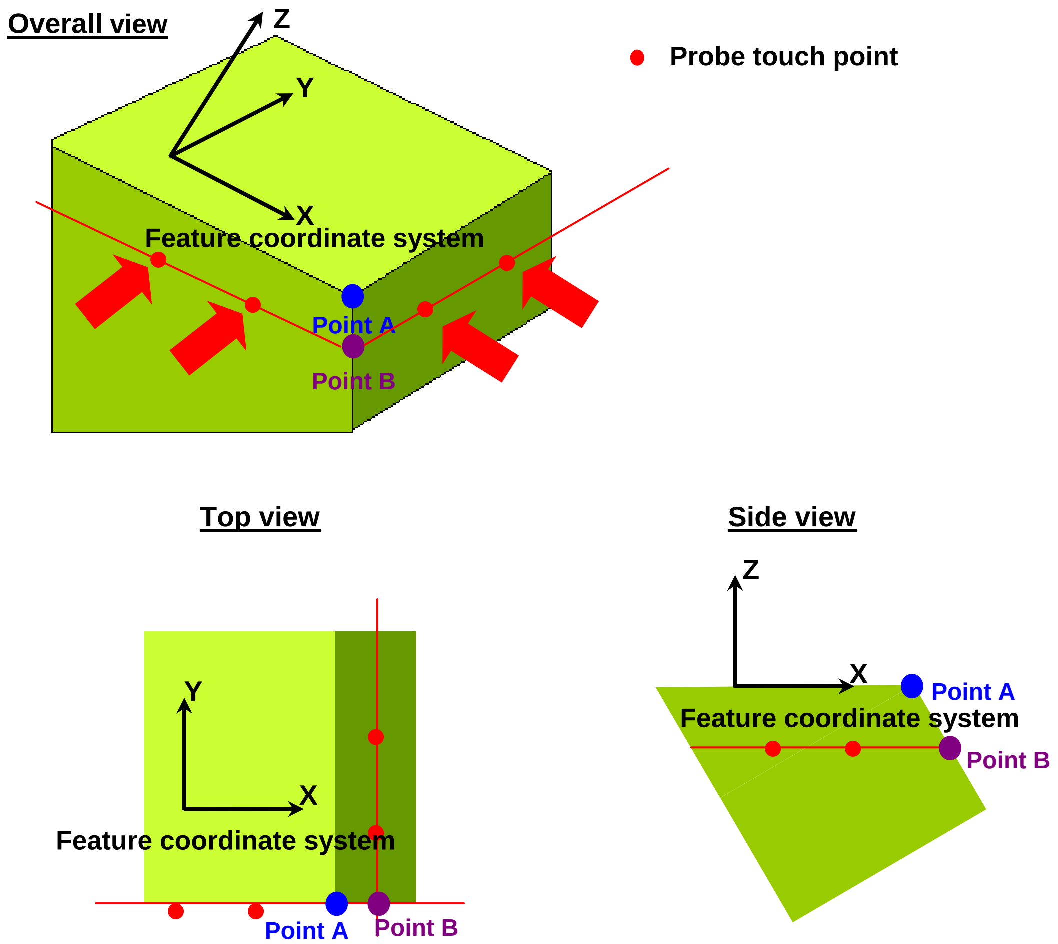
7.5.2.7 Measurement of corner outside/inside

NOTE

This function is enabled when bit 3 (CNR) of parameter No. 27222 is set to 1.

NOTE

In the case of corner outside/inside measurement, intersection point of two straight lines is calculated as the corner coordinate from measurement result. When touch plane of probe is tilted as following example, the corner coordinate point B is different from the corner coordinate point A of workpiece upper surface.
Therefore, in this case, the corner coordinate point A of workpiece upper surface cannot be calculated.



1. Input items

"WORK COORDINATE NO.M" and "MACRO VARIABLE" aren't displayed.
The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure

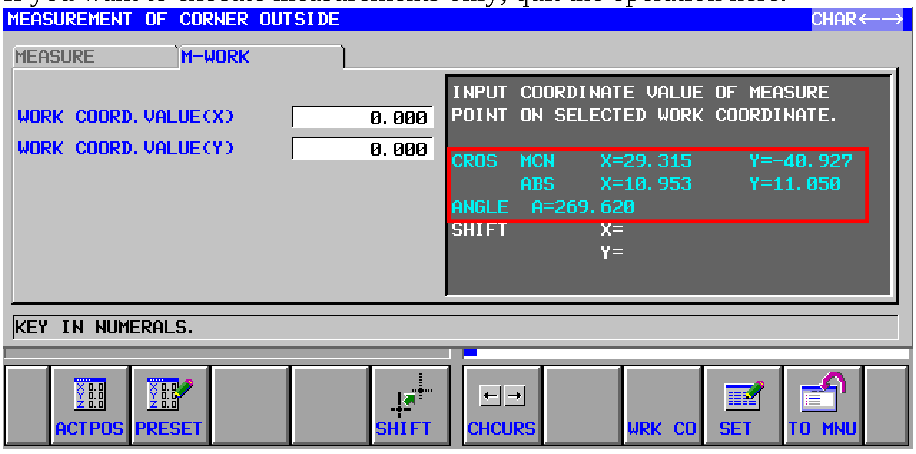
(1) Execute measurement procedure from (1) to (3) of “7.5.2.1 Single surface measurement probe z-axis” before manual measurement.

(2) Select “MEASUREMENT OF CORNER OUTSIDE/INSIDE” in the “WORK SET” tab of manual measurement menu screen.

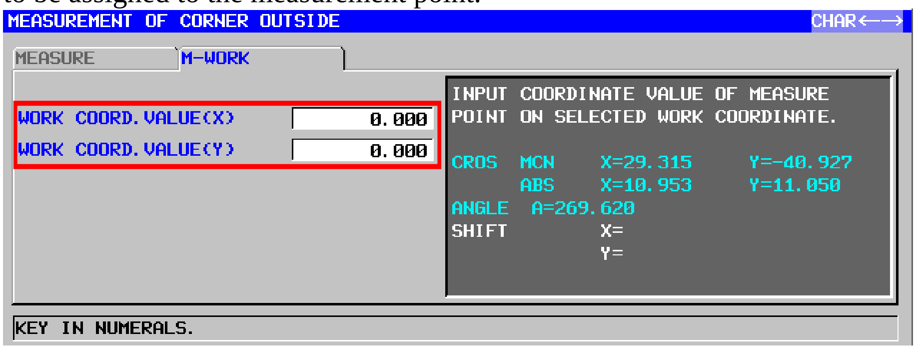
(3) Measurement execution procedure is same with the case that tilted working plane command mode is disabled. Select the plane and direction in a feature coordinate system about ”MEASURE PLANE” and “MEASURE DIRECTION”.

(4) After a measurement, select the “M-WORK” tab by pressing the [→] cursor key.

(5) Based on the measurement results on the four points, the angle of the corner and the intersection of the two sides making up the corner are displayed on the screen.
Absolute coordinate value of the measurement result is displayed in a feature coordinate system.
If you want to execute measurements only, quit the operation here.



(6) In “WORK COORDINATE VALUE” specify what coordinates in the feature coordinate system are to be assigned to the measurement point.



(7) Press the [SET] soft key, a difference between the measurement result and input value of “WORK COORDINATE VALUE” is set to the macro variables specified by parameter No.27259.
See “7.5.6 Macro Variable” for details.

(8) Press the [SHIFT] soft key, then a feature coordinate system is shifted by outputting incremental multiple command G68.4. However, if procedure of (7) isn’t executed, a feature coordinate system isn’t shifted.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.2.8 Angled work measurement

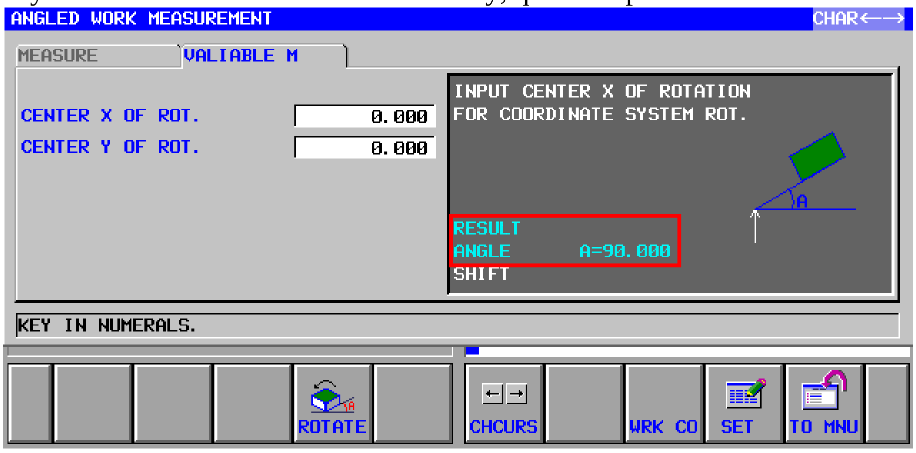
> **NOTE**
> This function is enabled when bit 2 (AWM) of parameter No. 27222 is set to 1.

1. Input items

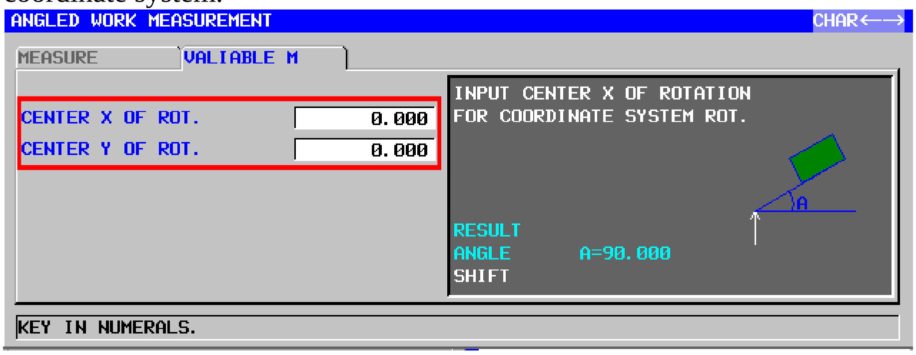
"MACRO VARIABLE" isn't displayed.
The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure

(1) Execute measurement procedure from (1) to (3) of "7.5.2.1 Single surface measurement probe z-axis" before manual measurement.
(2) Select "ANGLED WORK MEASUREMENT" in the "SET ERROR" tab of manual measurement menu screen.
(3) Measurement execution procedure is same with the case that tilted working plane command mode is disabled. Select the plane and direction in a feature coordinate system about "MEASURE PLANE" and "MEASURE DIRECTION".
(4) After a measurement, select the "VARIABLE M" tab by pressing the [→] cursor key.
(5) Based on the measurement results on the two points, the measured angle is displayed on the screen. If you want to execute measurements only, quit the operation here.



(6) "CENTER X OF ROT" specify coordinate position. Coordinate position specify in a feature coordinate system.



(7) Press the [SET] soft key, the measurement result and input value of “CENTER OF ROT” is set to the macro variables specified by parameter No.27259.
See “7.5.6 Macro Variable” for details.

(8) Press the [ROTATE] soft key, then a feature coordinate system is rotated by outputting incremental multiple command G68.4. However, if procedure of (7) isn’t executed, a feature coordinate system isn’t rotated.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.3 Measure of Manual Measurement Function

Measure of manual measurement function can be used in tilted working plane command mode.
The following contents are common in each measurement.

1. Input items

Input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure

(1) Execute measurement on the each manual measurement screen.
Each measurement procedure are same as “WORK SET OF MANUAL MEASUREMENT FUNCTION”.

(2) Procedure of setting to the tool offset after a measurement is the same with the case that tilted working plane command mode is disabled.
However, input a value in a feature coordinate system to ”TARGET VALUE”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.4 Work Set of Measurement Cycle Function

Work set of measurement cycle function can be used in tilted working plane command mode.
The measurement result isn’t set to a workpiece coordinate system. Instead of changing workpiece origin offset, a feature coordinate system is shifted by outputting incremental multiple command.

7.5.4.1 End face (x-axis direction) measurement (probe z-axis direction, probe x-axis direction)

1. Input items

Input item name	Input value
MEASUREMENT DIREC.	Select direction in a feature coordinate system
MEASURE POINT	Input value in a feature coordinate system
WORK CORD VALUE	Input value in a feature coordinate system
SETTING DEST	Unnecessary (Inputting value is ignored)

* The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure

(1) Select the MEM mode.

(2) Before a four-digit G block of measurement cycle, execute the following commands in the following order.
- Tilted working plane command G68.2
- Tool axis direction control command G53.1
- Tool length compensation

(3) Execute a four-digit G block of measurement cycle.
(a) The case bit 6 of parameter No.27220 is set to 1.
After a measurement, incremental multiple command G68.4 is automatically outputted. Then a feature coordinate system is shifted.

> **NOTE**
> After incremental multiple command is outputted, the macro variables specified by parameter No.27259 are initialized to the blank.

(b) The case bit 6 of parameter No.27220 is set to 0.
Incremental multiple command G68.4 isn't outputted. After a measurement, the argument data for incremental multiple command is set to the macro variable specified by parameter No.27259.

3. Measurement motion
Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.4.2 End face (y-axis direction) measurement (probe z-axis direction, probe x-axis direction)

1. Input items
Input items are same with the case of "End Face (X-axis Direction) Measurement".

2. Measurement procedure
This procedure is same with the case of "End Face (X-axis Direction) Measurement".

3. Measurement motion
Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.4.3 End face (z-axis direction) measurement (probe z-axis direction, probe x-axis direction)

1. Input items
Input items are same with the case of "End Face (X-axis Direction) Measurement".

2. Measurement procedure
This procedure is same with the case of "End Face (X-axis Direction) Measurement".

3. Measurement motion
Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.4.4 Outside diameter measurement (probe z-axis direction, probe x-axis direction)

1. Input items

Input item name	Input value
CENTER POINT	Input value in a feature coordinate system
HEIGHT OF MEAS.PT.	Input value in a feature coordinate system
WORK COORD VALUE	Input value in a feature coordinate system
SETTING DEST.	Unnecessary (Inputting value is ignored)

* The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure

This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.4.5 Inside diameter measurement (probe z-axis direction, probe x-axis direction)

1. Input items

Input items are similar with the case of “Outside Diameter Measurement”.

2. Measurement procedure

This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.4.6 Outside width measurement (probe z-axis direction, probe x-axis direction)

1. Input items

Input item name	Input value
MESUREMENT DIREC.	Select direction in a feature coordinate system
CENTER POINT	Input value in a feature coordinate system
HEIGHT OF MEAS.PT.	Input value in a feature coordinate system
WORK COORD VALUE	Input value in a feature coordinate system
SETTING DEST.	Unnecessary (Inputting value is ignored)

* The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure

This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.4.7 Inside width measurement (probe z-axis direction, probe x-axis direction)

1. Input items

Input items are similar with the case of “Outside Width Measurement”.

2. Measurement procedure

This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.4.8 Measurement of the outside of a corner/the Inside of a corner (probe z-axis direction, probe x-axis direction)

NOTE

This function is enabled when bit 3 (CNR) of parameter No. 27222 is set to 1.

1. Input items

Input item name	Input value
MEAS.STRT.PT.	Input value in a feature coordinate system
MEASUREMENT DIREC.	Select direction in a feature coordinate system
CORNER COORD VAL.	Input value in a feature coordinate system
HEIGHT OF MEAS.PT.	Input value in a feature coordinate system
WORK COORD VALUE	Input value in a feature coordinate system
SETTING DEST	Unnecessary (Inputting value is ignored)
SETTING MACRO VAL.	Unnecessary (Inputting value is ignored)

* The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure

This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.4.9 Measurement of the angle of a slanted workpiece (probe z-axis direction, probe x-axis direction)

NOTE
This function is enabled when bit 2 (AWM) of parameter No. 27222 is set to 1.

1. Input items

Input item name	Input value
MEASUREMENT DIREC.	Select direction in a feature coordinate system
MEAS.STRT.PT.	Input value in a feature coordinate system
HEIGHT OF MEAS.PT.	Input value in a feature coordinate system
CENTER OF ROT.	Input value in a feature coordinate system
SETTING MACRO VAL.	Unnecessary (Inputting value is ignored)

* The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure

This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.5 Measure of Measurement Cycle Function

Measure of measurement cycle function can be used in tilted working plane command mode.
The measurement result is set to the tool offset.
It is same with the case that tilted working plane command mode is disabled.

7.5.5.1 End face (x-axis direction) measurement (probe z-axis direction, probe x-axis direction)

1. Input items

Input item name	Input value
MESUREMENT DIREC.	Select direction in a feature coordinate system
MEASURE POINT	Input value in a feature coordinate system

* The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure

(1) Select the MEM mode.
(2) Before a four-digit G block of measurement cycle, execute the following commands in the following order.
- Tilted working plane command G68.2
- Tool axis direction control command G53.1
- Tool length compensation
(3) Execute a four-digit G block of measurement cycle.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.5.2 End face (y-axis direction) measurement (probe z-axis direction, probe x-axis direction)

1. Input items

Input items are same with the case of “End Face (X-axis Direction) Measurement”.

2. Measurement procedure

This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.5.3 End face (z-axis direction) measurement (probe z-axis direction, probe x-axis direction)

1. Input items

Input items are same with the case of “End Face (X-axis Direction) Measurement”.

2. Measurement procedure

This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.5.4 Outside diameter measurement (probe z-axis direction, probe x-axis direction)

1. Input items

Input item name	Input value
CENTER POINT	Input value in a feature coordinate system
HEIGHT OF MEAS.PT.	Input value in a feature coordinate system

* The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure

This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.5.5 Inside diameter measurement (probe z-axis direction, probe x-axis direction)

1. Input items

Input items are same with the case of “Outside Diameter Measurement”.

2. Measurement procedure

This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion
Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.5.6 Outside width measurement (probe z-axis direction, probe x-axis direction)

1. Input items

Input item name	Input value
CENTER POINT	Input value in a feature coordinate system
HEIGHT OF MEAS.PT.	Input value in a feature coordinate system

* The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure
This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion
Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.5.7 Inside width measurement (probe z-axis direction, probe x-axis direction)

1. Input items
Input items are same with the case of “Outside Width Measurement”.

2. Measurement procedure
This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion
Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.5.8 Outside width/inside width measurement (with a slant angle) (probe z-axis direction, probe x-axis direction)

NOTE
This function is enabled when bit 5 (GANG) of parameter No. 27220 is set to 1.
This function is disabled when bit 7 (NOY) of parameter No. 27222 is set to 1.

1. Input items

Input item name	Input value
CENTER POINT	Input value in a feature coordinate system
HEIGHT OF MEAS.PT.	Input value in a feature coordinate system

* The other input items are same with the case that tilted working plane command mode is disabled.

2. Measurement procedure
This procedure is same with the case of “End Face (X-axis Direction) Measurement”.

3. Measurement motion

Measurement motion is same with the case that tilted working plane command mode is disabled.
It works in a feature coordinate system.

7.5.6 Macro Variable

After a measurement, the argument data for incremental multiple command G68.4 are set to the macro variables specified by parameter No.27259.
Therefore, it is possible to output the incremental multiple command G68.4 in the user macro program.

G68.4 argument address	X argument	Y argument	Z argument	I argument	J argument	K argument
Macro variable number	n+0	n+1	n+2	n+3	n+4	

(Note) n : setting value of parameter No.27259

Set argument data for incremental multiple command are different from each measurement as follows.

Kind of measurement	X argument	Y argument	Z argument	I argument	J argument	K argument
End face (X-axis direction) Measurement	O					
End face (Y-axis direction) Measurement		O				
End face (Z-axis direction) Measurement			O			
Outside / inside diameter measurement (X-Y plane)	O	O				
Outside / inside diameter measurement (Y-Z plane)		O	O			
Outside / inside width measurement (X-Y plane, X-axis dir.)	O					
Outside / inside width measurement (X-Y plane, Y-axis dir.)		O				
Outside / inside width measurement (Y-Z plane, Y-axis dir.)		O				
Outside / inside width measurement (Y-Z plane, Z-axis dir.)			O			
Measurement of corner outside / inside (X-Y plane)	O	O				
Measurement of corner outside / inside (Y-Z plane)		O	O			
Angled work measurement (X-Y plane)	O	O		O		
Angled work measurement (Y-Z plane)		O	O		O	

(Note) O: set data

NOTE

The value of macro variables specified by parameter No.27259 are initialized to the blank in the following case.

1. Manual measurement function
   (1) When measurement menu screen is opened.
   (2) When the [SHIFT]soft key is pressed and the feature coordinate system is shifted.

2. Measurement cycle function
   (1) When measurement is executed.
   (2) When the feature coordinate system is shifted (parameter No.27220#6 = 1).

7.5.7 Parameter

7.5.7.1 Required parameters

For use of this function, the parameter must be set as described below.

(1) No.3402#6 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
3402		CLR						

[Data type] Bit type
[Standard value] 00000000
[System attribute] Independent parameter between paths
[Power supply re-turning on] Unnecessary

#6 CLR Reset button on the MDI panel, external reset signal, reset and rewind signal, and emergency stop signal
0 : cause reset state.
1 : cause clear state.

(2) No.3407#0 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
3407								C08

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary

#0 C08 If bit 6 (CLR) of parameter No. 3402 is set to 1, set a group of G codes to be placed in the cleared state when the CNC is reset by the reset key of the MDI panel, the external reset signal, the reset and rewind signal, or the emergency stop signal
0 : places the G code group 08 in the cleared state.
1 : does not place G code group 08 in the cleared state.

(3) No.3409#7 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
3409	CFH							

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary

#7 CFH When bit 6 (CLR) of parameter No. 3402 is 1, the reset key on the MDI panel, the external reset signal, the reset and rewind signal, or emergency stop will
0 : clear F codes, H codes (for the M series), D codes (for the M series), and T codes (for the T series).
1 : not clear F codes, H codes (for the M series), D codes (for the M series), and T codes (for the T series).

(4) No.5003#6 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
5003		LVK						

[Data type] Bit type
[Standard value] 00000000
[System attribute] Independent parameter between paths
[Power supply re-turning on] Unnecessary
#6 LVK Tool length compensation vector
0 : cleared by reset.
1 : not cleared, but held by reset.

(5) No.5006#6 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
5006		TOS						

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary
#6 TOS Tool length compensation
0 : is performed by an axis movement.
1 : is performed by shifting the coordinate system.

(6) No.5400#2 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
5400						D3R		

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary
#2 D3R When Reset is done by reset operation or reset signal from PMC, 3-dimensional coordinate system conversion mode, tilted working plane command mode and workpiece setting error compensation mode is
0 : canceled.
1 : not canceled.

(7) No.5400# 5 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
5400			LV3					

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary
#5 LV3 When system variables #100101 to #100132 (current position coordinates) and #100151 to #100182 (skip coordinates) are read in the tilted working plane command mode,
0 : the value of the workpiece coordinate system is read.
1 : the value of the feature coordinate system is read.

(8) No.6019#4 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
6019				MSV				

[Data type] Bit type
[Standard value] 00000000
[System attribute] Independent parameter between paths
[Power supply re-turning on] Unnecessary

#4 MSV When the tool length compensation offset of shifted type is used, Following system variables #5061 - #5080, #100151 - #100200 (Skip position)
0 : include tool length compensation offset or tool holder offset.
1 : do not include tool length compensation offset or tool holder offset.

(9) No.11221#0 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
11221								MTW

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary

#0 MTW In tilted working plane command mode, incremental multiple commands are
0 : Not used.
1 : Used.

(10) No.12380#5 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
12380			TWP					

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary

#5 TWP In tilted working plane command mode, Set-up guidance functions are
0 : not used.
1 : used.

(11) No.13451#1 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
13451							ATW	

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary

#1 ATW When I, J, and K are all set to 0 in a block that specifies a feature coordinate system setup command (G68.2), which is a tilted working plane command:
0 : An alarm PS5457 is issued.
1 : A feature coordinate system with a tilted plane angle of 0 degrees is assumed.

(12) No.14497 = 3637

14497	Macro program number executed when the [SHIFT] soft key is pressed

[Data type] Word type
[Standard value] 0
[Valid data range] 1- 99999999
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary

Macro program number executed when the [SHIFT] soft key is pressed on the manual measurement screen

(13) No.14856#0 = 0

	#7	#6	#5	#4	#3	#2	#1	#0
14856								GID

[Data type] Bit type
[Standard value] 00000000
[System attribute] Independent parameter between paths
[Power supply re-turning on] Unnecessary
#0 GID 0 : The setup function is available.
1 : The setup function is disabled.

(14) No.27220#0 = 1

	#7	#6	#5	#4	#3	#2	#1	#0
27220								CMPH

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary
#0 CMPH When a manual measurement functions or measurement cycle is executed,
0: An operation considering the probe length is performed.
1: An operation not considering the probe length is performed.
(Note)
Before a measurement cycle is started, a tool length compensation command for the probe length needs to be specified.

(15) No.27259 = Arbitrariness

27259	Macro variable start number for the argument of incremental multiple command storage

[Data type] Two word type
[Standard value] 0
[Valid data range] 100 - 89999
[System attribute] Independent parameter between paths
[Power supply re-turning on] Unnecessary
Start number of the macro variable area for storage the argument of incremental multiple command. In case of parameter set value is between 100 and 999, custom macro variable is used. Other case, P-code macro variable is used. The using number of macro variable is 6.

7.5.8 Cautions

There are the following three cautions for using this function.
(1) This function can be used in a machining center system only.
(2) This function can be used Table rotation type machine controlled with two table rotation axes only.
(3) This function can be used parameter No.27220#1=0 only.

	#7	#6	#5	#4	#3	#2	#1	#0
27220							CNTV	

[Data type] Bit type
[Standard value] 00000000
[System attribute] Common parameter between paths
[Power supply re-turning on] Unnecessary
#1 CNTV Upon completion of measurement at each measurement point in manual measurement:
0 : A retract movement is made by the distance specified to “ESCAPING DISTANCE FOR 2ND MEASUREMENT” of the measurement condition.
1 : A return movement is made to the position before the start of measurement. In a circle measurement, a movement is made to the center of the circle after the center position of the circle is established.

APPENDIX

A PARAMETERS

> ⚠ **WARNING**
> Be sure to use the parameters that have been set by the machine tool builder. If a parameter setting is modified, the measurement program may malfunction.
> If the measurement program malfunctions, sensors and measuring tools may be damaged and the operator may be injured.

A.1 REQUIRED PARAMETERS

When the set-up guidance functions of MANUAL GUIDE *i* are used, the parameter settings must be made as described below.

(1) No.12381≠0
Set the start number of the P-CODE macro variable area for preserving measurement condition data.

(2) No.12382≠0
Set the start number of the P-CODE macro variable area for preserving calibration data.

(3) No.12383≠0
Set the start number of the P-CODE macro variable area used as a work area for measurement function execution.

(4) No.12384≠0
Set the start number of the P-CODE macro variable area for preserving measurement results.

(5) No.12385≠0
Set the number of variables in the P-CODE macro variable area for preserving measurement results.

When the manual measurement function is used, the parameter settings described below must also be made.

(1) No.12386≠0
Set the address of the R signal of the PMC used to control the operation of the manual measurement function.

(2) No.12388≠0
Set the number of the macro program used to execute manual measurements when the [MESURE] key is pressed.

When the parameter No.5006#6 = 1 in FS16*i*/18*i*/21*i*-MB and FS0*i*-MC, the parameter settings must be made as described below.

(1) No.6006#4 = 1
When reading system variables with tool length compensation without axis movement, System variables #5041~#5048 (current position), #5061~#5068 (skip signal position) include the actual tool length compensation value.

The set-up guidance functions uses P-CODE variables.
When the set-up guidance functions are used on FS30*i*/31*i*/32*i* or 0*i*-F/0*i*-D, the following parameters must be set.

- No.9051≠0
  Set the area number for the P-CODE variables (#10000 and up) used by the macro executor of each path.

- No.9052≠0
  Set the area number for the extended P-CODE variables (#20000 and up) used by the macro executor of each path.

- No.9053≠0
  Set the total number of P-CODE variables (#10000 and up).

- No.9054≠0
  Set the total number of extended P-CODE variables (#20000 and up).

(Supplemental explanation)

(1) Note
P-CODE variables that the set-up guidance function uses cannot overlap P-CODE variables that MTB uses.

(2) In the case that MTB does not make the P-CODE macro

<1> Using P-CODE variables (#10000 and up)

No.9051 = 90 : machining center
= 91 : lathe

No.9053 = The number of P-CODE variables (#10000 and up).
- In the case of standard specification.
No.9053 = 1200
- In the case of extended number of workpiece measurement condition groups
No.9053 = (No.12384 value - No.12381 value) + (No.12385 value +1)

<2> Using P-CODE variables (#20000 and up)

No.9052 = 90 : machining center
= 91 : lathe

No.9054 = The number of extended P-CODE variables (#20000 and up).
- In the case of standard specification.
No.9054 = 1200
- In the case of extended number of workpiece measurement condition groups
No.9054 = (No.12384 value - No.12381 value) + (No.12385 value +1)

(3) In the case that MTB makes the P-CODE macro

<1> Using P-CODE variables (#10000 and up) on MTB P-CODE macro, and using P-CODE variables (#20000 and up) on the set-up guidance functions

No.9051 = Area number of P-CODE variables (#10000 and up)

No.9052 = Area number of extended P-CODE variables (#20000 and up)

No.9053 = Number of P-CODE variables (#10000 and up)
- The number of P-CODE variables that P-CODE macro of MTB uses.

No.9054 = Number of extended P-CODE variables (#20000 and up)
- In the case of standard specification
  No.9054 = 1200
- In the case of extended number of workpiece measurement condition groups
  No.9054 = (No.12384 value - No.12381 value) + (No.12385 value +1)

<2> Using P-CODE variables (only #10000 and up)
No.9051 = Area number of P-CODE variables (#10000 and up)

No.9053 = Number of P-CODE variables (#10000 and up)
- In the case of standard specification
  No.9053 = 1200 + The number of P-CODE variables that P-CODE macro of MTB uses.
- In the case of extended number of workpiece measurement condition groups
  No.9053 = (No.12384 value - No.12381 value) + (No.12385 value +1) + The number of P-CODE variables that P-CODE macro of MTB uses.

<3> Using P-CODE variables (only #20000 and up)
No.9052 = Area number of extended P-CODE variables (#20000 and up)

No.9054 = Number of extended P-CODE variables (#20000 and up)
- In the case of standard specification
  No.9054 = 1200 + The number of P-CODE variables that P-CODE macro of MTB uses.
- In the case of extended number of workpiece measurement condition groups
  No.9054 = (No.12384 value - No.12381 value) + (No.12385 value +1) + The number of P-CODE variables that P-CODE macro of MTB uses.

(Example1: In the case of standard specification)
(The number of P-CODE variables that P-CODE macro of MTB uses) = 0
(The number of P-CODE variables that the set-up guidance functions uses) = 1200 (#10000 and up)
No.9053 = 1200
No.9054 = 0

No.12381= 10000
No.12382= 10180
No.12383= 10300
No.12384= 10500
No.12385= 699

(Example2: In the case of standard specification)
(The number of P-CODE variables that P-CODE macro of MTB uses) = 3000 (#10000 and up)
(The number of P-CODE variables that the set-up guidance functions uses) = 1200 (#20000 and up)
No.9053 = 3000
No.9054 = 1200

No.12381= 20000
No.12382= 20180
No.12383= 20300
No.12384= 20500
No.12385= 699

(Example3: In the case of standard specification)

(The number of P-CODE variables that P-CODE macro of MTB uses) =
3000 (#10000 and up : from #10000 to #12999)

(The number of P-CODE variables that the set-up guidance functions uses) =
1200 (#10000 and up : from #13000 to #14199)

No.9053 = 4200
No.9054 = 0

No.12381= 13000
No.12382= 13180
No.12383= 13300
No.12384= 13500
No.12385= 699

(Example4: In the case of extended number of workpiece measurement condition groups)

(The number of P-CODE variables that P-CODE macro of MTB uses) =
3000 (#10000 and up : from #10000 to #12999)

(The number of P-CODE variables that the set-up guidance functions uses) =
1400 (#10000 and up : from #13000 to #14399)

No.9053 = 4400
No.9054 = 0

No.12381= 13000
No.12382= 13290 ⇒ The number of used variables increases because of extended number of workpiece measurement condition groups.
No.12383= 13500 ⇒ The number of used variables increases because of extensded number of workpiece measurement condition groups.
No.12384= 13700
No.12385= 699

A.2 PARAMETER DESCRIPTIONS

	#7	#6	#5	#4	#3	#2	#1	#0
12380		ALCHK			SHRT	RPDF		P CRY

(Default value = 0000000)

[Data type] Bit
[Path attribute] Common to all paths

ALCHK If the result of a measurement cycle fails to fall in the feedback range:
- 1: No alarm is issued.
- 0: An alarm is issued.

SHRT In measurement of the diameter of a stylus ball and measurement of the inner and outer diameters:
- 1: At each measurement point, the first measurement and the second measurement are made in succession, then measurement processing proceeds to the next point.
- 0: All measurement points are measured under the first measurement condition, then the second measurement is made.

RPDF When a movement is made to the measurement start point:
- 1: The rapid traverse rate is used.
- 0: The "feedrate to measurement start point" of the measurement condition is used.

CRY In measurement of the diameter of a stylus ball in the probe Z-axis direction, shift amount measurement, outer diameter measurement, and inner diameter measurement:
- 1: The Y-axis direction has priority as the measurement direction.
- 0: The X-axis direction has priority as the measurement direction.

12381	Measurement condition variable start number

(Default value = 10000)

[Data type] Two-word
[Valid data range] 0 to 99999
[Path attribute] Common to all paths

Start number for the macro variable area where measurement conditions are set and held

12382	Calibration variable start number

(Default value = 10180)

[Data type] Two-word
[Valid data range] 0 to 99999
[Path attribute] Common to all paths

Start number for the macro variable area where calibration data is set and held.
The result obtained using the measurement preparation function is stored in this variable.

12383	Measurement execution variable start number

(Default value = 10300)

[Data type] Two-word
[Valid data range] 0 to 99999
[Path attribute] Common to all paths

Variable area used in making measurements

12384	Measurement result storage variable start number

(Default value = 10500)

[Data type] Two-word
[Valid data range] 0 to 99999
[Path attribute] Common to all paths

Start number for the macro variable area for holding measurement results

12385	Number (1) of variables for storing measurement results

(Default value = 699)

[Data type] Word
[Valid data range] 0 to 9999
[Path attribute] Common to all paths

Set the number of macro variables that can be used to preserve the result of measurement. Set a value obtained by subtracting 1 from the number of macro variables actually used.

> **NOTE**
> In connection with parameter No. 12381 to parameter No. 12385, the number of macro variables (P-CODE macro variables) that can be actually used depends on the compile parameter (macro executor parameter in the case of Series 0*i*-F/0*i*-D/30*i* /31*i* /32*i*) setting of the machine tool builder. For details, refer to the manual issued by the machine tool builder.

12386	PMC signal for measurement

(Default value = 951)

[Data type] Word
[Valid data range] 0 to 9999
[Path attribute] Common to all paths

Parameter used to specify the address of the R signal for PMC used with the measurement function.

12387	Number for a P-CODE macro program for selecting a tool

(Default value = 3800)

[Data type] Two-word
[Valid data range] 0 to 99999999
[Path attribute] Common to all paths

Number representing the user macro program executed when the [TL-SEL] soft key is pressed

12388	Number for a P-CODE macro program for making measurements

(Default value = 3600)

[Data type] Two-word
[Valid data range] 0 to 99999999
[Path attribute] Common to all paths

Number representing the user macro program executed when the [MESURE] soft key is pressed

12390	Orientation M code for positioning the spindle at 0°

(Default value = 0)

12391	Orientation M code for positioning the spindle at 90°

(Default value = 0)

12392	Orientation M code for positioning the spindle at 180°

(Default value = 0)

12393	Orientation M code for positioning the spindle at 270°

(Default value = 0)

[Data type] Two-word
[Valid data range] 0 to 99999999
[Path attribute] Common to all paths

12394	User P-CODE macro program called in making manual tool measurements

(Default value = 0)

12395	User P-CODE macro program called in making manual workpiece measurements

(Default value = 0)

12396	User P-CODE macro program called in making automatic tool measurements

(Default value = 0)

12397	User P-CODE macro program called in making automatic workpiece measurements

(Default value = 0)

[Data type] Two-word
[Valid data range] 0 to 9999
[Path attribute] Common to all paths

Number +0 is called at the start of measurement, and number +1 is called at the end of measurement.

> **NOTE**
> If an alarm condition occurs during measurement, no measurement-end program is called.

	#7	#6	#5	#4	#3	#2	#1	#0
14850						#2		

(Default value = 0000000)

[Data type] Bit
[Path attribute] Common to all paths

#2 On the manual measurement screen:
- 0: The [TO MNU] soft key is displayed. Pressing this soft key returns the screen display to the menu selection screen.
- 1: The [TO MNU] soft key is not displayed.

	#7	#6	#5	#4	#3	#2	#1	#0
27220	ANG		GANG	CANG	CCNT	ROT	CNTV	CMPH

(Default value = 0000000)

[Data type] Bit
[Path attribute] Common to all paths

CMPH When a measurement cycle is executed:
- 1: An operation not considering the probe length is performed. Before a measurement cycle is started, a tool length compensation command for the probe length needs to be specified.
- 0: An operation considering the probe length is performed.

CNTV Upon completion of measurement at each measurement point in manual measurement:
- 1: A return movement is made to the position before the start of measurement. In a circle measurement, a movement is made to the center of the circle after the center position of the circle is established.
- 0: A retract movement is made by the distance specified by ESCAPING DISTANCE FOR 2ND MEASUREMENT of the measurement condition.

ROT At the end of a slanted workpiece angle measurement cycle, a coordinate system rotation command is automatically:
- 1: Executed.
- 0: Not executed.

CCNT In a manual outside diameter or inside diameter measurement, when the measurement start position is not on a center line of the circle:
- 1: A correct measurement cannot be made.
- 0: A correct measurement can be made.

CANG In a circle measurement:
- 1: A measurement direction can be specified with an arbitrary angle.
- 0: A measurement direction parallel with the basic axis is used.

GANG In a groove width/projection width measurement:
1: A slanted groove/projection can be measured.
0: No slanted groove/projection can be measured.

ANG In a workpiece slant measurement, an angle within the following range is output:
1: $-180° \le \theta \le 180°$
0: $0° \le \theta \le 360°$

	#7	#6	#5	#4	#3	#2	#1	#0
27221	TLN	PAM		CAX	WRX	WRZ	TLX	TLZ

(Default value = 0000000)

[Data type] Bit
[Path attribute] Common to all paths

TLZ A tool measurement cycle with the tool facing the Z-axis direction is:
1: Not displayed.
0: Displayed.

TLX A tool measurement cycle with the tool facing the X-axis direction is:
1: Not displayed.
0: Displayed.

WRZ A workpiece measurement cycle with the probe facing the Z-axis direction is:
1: Not displayed.
0: Displayed.

WRX A workpiece measurement cycle with the probe facing the X-axis direction is:
1: Not displayed.
0: Displayed.

CAX A C axis measurement cycle is:
1: Not displayed.
0: Displayed.

PAM The following measurement cycles is:
1: Available
0: Not available
1) Measuring angle of line by 2 holes (simple measurement)
2) Measuring center of circle by 3 holes (simple measurement)
3) Measuring cross of diagonal by 4 holes (simple measurement)
4) Measuring center of circle by 3 holes (work set)
5) Measuring cross of diagonal by 4 holes (work set)

TLN A milling tool measurement (non-contact type) cycle is:
1: Displayed.
0: Not displayed.

	#7	#6	#5	#4	#3	#2	#1	#0
27222	NOY	WSC			CNR	AWM	RST	RCR

(Default value = 0000000)

[Data type] Bit
[Path attribute] Common to all paths

RCR An outside diameter/inside diameter measurement cycle of work rotation type is:
1: Displayed.
0: Not displayed.

RST Measurement cycles for the work rotation type of stylus ball and for center displacements (A and B) are:
1: Displayed.
0: Not displayed.

AWM A measurement cycle for measuring an inclined workpiece is:
1: Displayed.
0: Not displayed.

CNR A measurement cycle for the inner and outer angles of a corner is:
1: Displayed.
0: Not displayed.

WSC workpiece setting error measurement is:
1: Performed
0: Not performed.

NOY Y-axis measurement cycle and input data in the Y-axis direction are:
1: Displayed.
0: Not displayed.

	#7	#6	#5	#4	#3	#2	#1	#0
27223		MDL	CLR	LST	OFS	CMV	SRO	EHI

(Default value = 0000000)

[Data type] Bit
[Path attribute] Common to all paths

EHI On the input screen for an inside diameter measurement cycle, the input item "ESCAPE HIGHT AT CIRCLE CENTER" is:
1: Displayed.
0: Not displayed.

SRO In a measurement cycle of work rotation type, rotation axis positioning is performed by using:
1: Spindle orientation M code
0: C-axis positioning

CMV In a manual measurement of work rotation type, rotation axis positioning at a specified angle is:
1: Performed automatically.
0: Not performed.

OFS In the user macro called at the measurement cycle, the variable number to refer to the argument at the measurement cycle is converted.
1: is converted.
0: is not converted
(It converts it into the variable number of the argument for M offset of the FS18i-TB compound machine.)

LST When [MESLST] is pressed during operation:
1: A warning is displayed.
0: A measurement result list is displayed.

CLR On the measurement condition setting screen, CLEARANCE DISTANCE FOR MEASUR CYCLE is:
1: Displayed. A move distance for the first measurement in a measurement cycle is calculated from the value set here.
0: Not displayed. A move distance for the first measurement in a measurement cycle is calculated from APPROACH DISTANCE FOR 1ST MEASUREMENT.

MDL After a measurement cycle is executed, the states of the modal G codes and F codes are:
1: Not returned to the state before the cycle execution.
0: Returned to the state before the cycle execution.

	#7	#6	#5	#4	#3	#2	#1	#0
27224			GRP		#3		RAN	ZAP

(Default value = 0000000)

[Data type] Bit
[Path attribute] Common to all paths

GRP The input item MEASURE CONDITION is:
1: Not displayed. (The number of measurement condition groups is assumed to be 1.)
0: Displayed.

#3 On the [MEASURE] tab screen of the tool measurement screen in manual measurement, the input item “TOOL ROTATION CMD” and “TOOL ROTATION SPEED” is:
1: Displayed
0: Not displayed

ZAP On the measurement cycle input screen, the input item APROCH DISTANCE in the tool axis direction is:
1: Not displayed.
0: Displayed.

RAN On the measurement cycle input screen, the input items OK RANGE and FEED BACK RANGE are:
1: Not displayed.
0: Displayed.

	#7	#6	#5	#4	#3	#2	#1	#0
27225		**STB**	**STA**					

(Default value = 0000000)

[Data type] Bit
[Path attribute] Common to all paths

STA Stylus ball center offset measurement-A is:
1: Not displayed.
0: Displayed.

STB Stylus ball center offset measurement-B is:
1: Not displayed.
0: Displayed.

	#7	#6	#5	#4	#3	#2	#1	#0
27226			**Y-Z**	**X-Y**				

(Default value = 0000000)

[Data type] Bit
[Path attribute] Common to all paths

X-Y In plane measurement on the manual measurement screen:
1: Only the X-Y plane can be measured.
0: Planes other than the X-Y plane can be measured.

Y-Z In plane measurement on the manual measurement screen:
1: Only the Y-Z plane can be measured.
0: Planes other than the Y-Z plane can be measured.

Only one of X-Y and Y-Z is enabled. When multiple bits are set, X-Y and Y-Z are enabled in this order.

	#7	#6	#5	#4	#3	#2	#1	#0
27228	**MSK**				**#3**	**#2**		

(Default value = 0000000)

[Data type] Bit
[Path attribute] Common to all paths

MSK Tool measurement function by using Multi-skipi signal is:
1: Available
0: Not available

#2 The number of measurement times in the measurement cycle (Tool measurement) is:
1: One time
0: Two times

#3 The number of measurement times in the measurement cycle (Work measurement) is:
1: One time
0: Two times

27230	Measurement direction in outside diameter measurement of work rotation type (probe Z-axis direction)

[Data type] Word
[Valid data range] -2 to 2
[Path attribute] Common to all paths

Measurement direction in execution of a measurement cycle for outside diameter measurement of work rotation type (probe Z-axis direction)

Setting	Measurement direction
1	+X direction
-1	-X direction
2	+Y direction
-2	-Y direction

NOTE
When 0 is set, the -X direction is used.

27231	Measurement direction in inside diameter measurement of work rotation type (probe Z-axis direction)

[Data type] Word
[Valid data range] -2 to 2
[Path attribute] Common to all paths

Measurement direction in execution of a measurement cycle for inside diameter measurement of work rotation type (probe Z-axis direction).
This parameter is reference also when a measurement cycle for stylus ball diameter measurement, stylus ball center offset measurement-A, or stylus ball center offset measurement-B is executed.

Setting	Measurement direction
1	+X direction
-1	-X direction
2	+Y direction
-2	-Y direction

NOTE
When 0 is set, the +X direction is used.

27232	Measurement direction in outside diameter measurement of work rotation type (probe X-axis direction)

[Data type] Word
[Valid data range] -2 to 2
[Path attribute] Common to all paths

Measurement direction in execution of a measurement cycle for outside diameter measurement of work rotation type (probe X-axis direction)

Setting	Measurement direction
1	+Y direction
-1	-Y direction
2	+Z direction
-2	-Z direction

NOTE
When 0 is set, the -Z direction is used.

27233	Measurement direction in inside diameter measurement of work rotation type (probe X-axis direction)

[Data type] Word
[Valid data range] -2 to 2
[Path attribute] Common to all paths

Measurement direction in execution of a measurement cycle for inside diameter measurement of work rotation type (probe X-axis direction).
This parameter is reference also when a measurement cycle for stylus ball diameter measurement, stylus ball center offset measurement-A, or stylus ball center offset measurement-B is executed.

Setting	Measurement direction
1	+Y direction
-1	-Y direction
2	+Z direction
-2	-Z direction

NOTE
When 0 is set, the +Z direction is used.

27240	M code for positioning the workpiece spindle at 0°

27241	M code for positioning the workpiece spindle at 90°

27242	M code for positioning the workpiece spindle at 180°

27243	M code for positioning the workpiece spindle at 270°

27244	M code for positioning the workpiece spindle at 120°

27245	M code for positioning the workpiece spindle at 240°

[Data type] 2-word
[Valid data range] 0 to 99999999
[Path attribute] Common to all paths

Specify a spindle orientation M code for positioning the workpiece spindle at a desired angle. These parameters are referenced when a measurement cycle of work rotation type is executed.

NOTE
These parameters are enabled only when bit 0 (SRO) of parameter No. 27223 is set to 1.

27246	WRKROT

[Data type] 2-word
[Valid data range] 0 to 999999
WRKROT Default macro variable number used to feed back a workpiece rotation angle

27247	PROBOFS

[Data type] Word
[Valid data range] 0 to 9999
PROBOFS Offset start number for setting a probe length

27248	ROTPGNO

[Data type] 2-word
[Valid data range] 0 to 99999999
[Default value] 3820 (FANUC standard macro number)
ROTPGNO Macro program number executed when the [ROTATE] soft key is pressed on the manual measurement screen

27251	TLCPGMNO

[Data type] 2-word
[Valid data range] 0 to 99999999
[Path attribute] Specific to a path
[Default value] 3860 (FANUC standard macro number)
TLCPGMNO The number of the macro program which is executed for activating tool lenth offset in the feed-back of the measurement result when [SETTING] softkey is depressed in the manual measurement of probe length.
In case of using the macro program customized in a customer, set the macro program number. If the value 0 is set, this function is not available.

27252	TLCPGANO

[Data type] 2-word
[Valid data range] 0 to 99999999
[Path attribute] Specific to a path
[Default value] 3860 (FANUC standard macro number)
TLCPGANO The number of the macro program which is executed for activating tool length offset when the measurement result is feed-backed in the measurement cycle of probe lenth.
In case of using the macro program customized in a customer, set the macro program number. If the value 0 is set, this function is not available.

27254	Lower limit value of tool revolution in tool measurement

[Data type] 2-word
[Valid data range] 0 to 99999999
[Default value] 0
[Path attribute] Specific to a path
Set the lower limit value of tool revolution in case of executing tool measument by rotating a tool. If the value 0 is set, the lower limit value is not checked.

27255	Upper limit value of tool revolution in tool measurement

[Data type] 2-word
[Valid data range] 0 to 99999999
[Default value] 0
[Path attribute] Specific to a path
Set the upper limit value of tool revolution in case of executing tool measument by rotating a tool. If the value 0 is set, the upper limit value is not checked.

27256	TOLROTNO

[Data type] 2-word
[Valid data range] 0 to 99999999
[Default value] 0
[Path attribute] Specific to a path
TOLROTNO In the tool measurment of a rotating tool, set the number of the macro program which is executed in case of rotating a tool.
If the value 0 is set, the standard macro program for the tool measurement is executed.
The number of the macro program for stopping a tool revolution is “TOLROTNO+1”.

27257	TOLPCDNO

[Data type] 2-word
[Valid data range] 0 to 9
[Default value] 0
[Path attribute] Specific to path

TOLPCDNO In the tool measurement of a ratating tool, this parameter is refered to the argument P for selecting spindle when tool rotate command is output.
In case of control the rotating tool by using the optional function “Spindle control with servo motor”, the parameter No.11010 is refered.

27258	MSKPNUM

[Data type] 2-word
[Valid data range] 1 to 4
[Default value] 0
[Path attribute] Specific to a path

MSKPNUM Skip signal number used in the measurement condition of tool measurement A through D.
Set the value like “dcba”.
a : the value of the skip signal No.P used in the measurment condition A
b : the value of the skip signal No.P used in the measurment condition B
c : the value of the skip signal No.P used in the measurment condition B
d : the value of the skip signal No.P used in the measurment condition B

B ALARMS

If the setting of an input program or one or more parameters is incorrect, or a measurement condition or any other data is incorrect, a P/S alarm listed below is issued.
If any P/S alarm other than those listed below is issued, refer to an applicable NC operation manual.

> **NOTE**
> An alarm of the Series 0*i*-F/0*i* –D/30*i* /31*i* /32*i* is an MC alarm.

Alarm No.		Description	
Series 0*i*-C/ 16*i*/18*i* /21*i*	Series 0*i*-F/0*i*-D/ 30*i*/31*i* /32*i*		
3128	3728	Cause	An improper starting angle is specified.
		Measure	When performing positioning with the spindle orientation function, set "STARTING ANGLE" within the range that can be output with the spindle orientation M code specified in the parameter.
3129	3729	Cause	An improper pitch angle is specified.
		Measure	When performing positioning with the spindle orientation function, set "PITCH ANGLE" within the range that can be output with the spindle orientation M code specified in the parameter.
3130	3730	Cause	The probe length setting is not larger than 0.
		Measure	Perform calibration to measure the length of the probe, or enter the probe length on the calibration data setting screen.
3131	3731	Cause	The setting of the stylus ball diameter in the X-axis direction is not larger than 0.
		Measure	Perform calibration to measure the diameter of the stylus ball, or enter the diameter of the stylus ball on the calibration data setting screen.
3132	3732	Cause	The setting of the stylus ball diameter in the Y-axis direction is not larger than 0.
		Measure	Perform calibration to measure the diameter of the stylus ball, or enter the diameter of the stylus ball on the calibration data setting screen.
3133	3733	Cause	No offset value in the X-axis direction for the stylus position has been set.
		Measure	Perform calibration to measure the offset value for the stylus position, or enter the offset value for the stylus position on the calibration data setting screen.
3134	3734	Cause	No offset value in the Y-axis direction for the stylus position has been set.
		Measure	Perform calibration to measure the offset value for the stylus position, or enter the offset value for the stylus position on the calibration data setting screen.
3135	3735	Cause	The feedrate for the first measurement cycle is not higher than 0.
		Measure	On the measurement condition setting screen, set the feedrate for the first measurement cycle.
3136	3736	Cause	The approach distance for the first measurement cycle is not larger than 0.
		Measure	On the measurement condition setting screen, set the approach distance for the first measurement cycle.
3137	3737	Cause	The feedrate for the second measurement cycle is not higher than 0.
		Measure	On the measurement condition setting screen, set the feedrate for the second measurement cycle.
3138	3738	Cause	The overtravel distance for measurement is not larger than 0.
		Measure	On the measurement condition setting screen, set the overtravel distance for measurement.

Alarm No. Series 0*i*-C/16*i*/18*i* /21*i*	Alarm No. Series 0*i*-F/0*i*-D/30*i*/31*i* /32*i*	Description	
3139	3739	Cause	The feedrate of movement to the measurement start point is not higher than 0.
		Measure	On the measurement condition setting screen, set the feedrate of movement to the measurement start point.
3140	3740	Cause	The return distance after contact in the second measurement cycle is not larger than 0.
		Measure	On the measurement condition setting screen, set the return distance after contact in the second measurement cycle.
3141	3741	Cause	The position of the sensor signal is incorrect.
		Measure	Check the state of the sensor signal.
3142	3742	Cause	The probe has not touch the measurement position.
		Measure	Change the measurement start position, or check the approach distance. For automatic measurement, make sure that the measurement position for the measurement cycle has been entered.
3143	3743	Cause	The probe touched the workpiece during approach in the axis direction.
		Measure	Make sure that the measurement position for the measurement cycle has been entered.
3144	3744	Cause	The return distance for the first measurement cycle (measurement distance for the second measurement cycle) is not larger than 0.
		Measure	On the measurement condition setting screen, set the return distance for the first measurement cycle.
3145	3745	Cause	The entered measurement condition value is incorrect.
		Measure	Make sure the entered measurement condition value is not greater than the number of groups that can be used.
3146	3746	Cause	The entered measurement direction value is incorrect.
		Measure	Check the entered measurement direction value.
3150	3750	Cause	The tool failed to touch the tool.
		Measure	Check the measurement start position, or check the approach distance. For automatic measurement, make sure that the measurement position for the measurement cycle has been entered.
3156	3756	Cause	It is impossible to perform measurement, using spindle orientation.
		Measure	The spindle orientation function is an option. If the option is available, check the settings of parameter Nos. 12390 to 12393.
3158	3758	Cause	The number of measurement points is incorrect.
		Measure	The value of "MEASUREMENT POINT" is beyond the maximum allowable value. Modify the value to a proper number.
3159	3759	Cause	Positioning at a specified angle is impossible.
		Measure	When positioning is performed with the spindle orientation function, a spindle orientation M code for positioning at an angle found from "STARTING ANGLE" and "PITCH ANGLE" cannot be output. Set a value within the range that can be output with the spindle orientation M code specified in the parameter.
3160	3760	Cause	No number for the workpiece coordinate system to which feedback is to be directed has been entered.
		Measure	Check the number entered for the workpiece coordinate system to which feedback is to be directed.
3161	3761	Cause	The number entered for the workpiece coordinate system to which feedback is to be directed is incorrect.
		Measure	Check the number entered for the workpiece coordinate system to which feedback is to be directed.

Alarm No.		Description	
Series 0*i*-C/ 16*i*/18*i* /21*i*	Series 0*i*-F/0*i*-D/ 30*i*/31*i* /32*i*		
3162	3762	Cause	An option corresponding to the tool offset number or workpiece coordinate number to which feedback is to be directed is unavailable.
		Measure	Check the tool offset number or workpiece coordinate number to which feedback is to be directed and the item to which tool offset is to be set.
3163	3763	Cause	No workpiece coordinate value (first axis) has been entered.
		Measure	Make sure that the workpiece coordinate value (first axis) has been entered.
3164	3764	Cause	No workpiece coordinate value (second axis) has been entered.
		Measure	Make sure that the workpiece coordinate value (second axis) has been entered.
3166	3766	Cause	The axis specified as a feedback destination is invalid.
		Measure	Check the value entered in "OFFSET KIND" as a feedback destination.
3167	3767	Cause	The tool offset number for a feedback destination is incorrect.
		Measure	Check the value entered as the tool offset number for the feedback destination.
3168	3768	Cause	The tool offset number for a feedback destination is incorrect.
		Measure	Check the value entered as the tool offset number for the feedback destination.
3169	3769	Cause	The value entered as a feedback range is incorrect.
		Measure	Check the values entered as the OK and feedback ranges.
3170	3770	Cause	The measurement result failed to fall in the feedback range.
		Measure	Check the value entered as the feedback range and the measurement result.
3171	3771	Cause	The argument value for the measurement result number is incorrect.
		Measure	Check the number entered when information is loaded from a list of measurement results.
3172	3772	Cause	No measurement result that matches the argument value for the measurement result number was found.
		Measure	Check the number entered when information is loaded from a list of measurement results.
3177	3777	Cause	An unauthorized attempt was made to access tool management data.
		Measure	Make sure that the tool management option is available and running normally.
3178	3778	Cause	An unauthorized attempt was made to access a macro variable.
		Measure	Make sure that the number set for a macro variable used with the set-up guidance function is correct. (Parameter Nos. 12381 to 12385).
3179	3779	Cause	An unauthorized attempt was made to access a parameter.
		Measure	Make sure that the parameters set for the set-up guidance and tool management functions are correct.
3180	3780	Cause	An unauthorized attempt was made to access a tool offset value.
		Measure	Make sure that the offset value for a specified tool can be read and written normally.
3181	3781	Cause	The specified tool number was not found.
		Measure	Check the tool number entered as a feedback destination.
3182	3782	Cause	The specified group number was not found.
		Measure	Check the group number entered as a feedback destination.
3183	3783	Cause	The value specified in parameter No.14825 is incorrect.
		Measure	Make sure that the value specified in parameter No.14825 is correct.
3184	3784	Cause	The specified offset type is incorrect.
		Measure	Check the offset type entered as a feedback destination.

Alarm No.		Description	
Series 0*i*-C/ 16*i*/18*i* /21*i*	**Series 0*i*-F/0*i*-D/ 30*i*/31*i* /32*i***		
3185	3785	Cause	An offset number and an offset type were specified at the same time.
		Measure	Make sure that the offset number and an offset type have not been specified at the same time.
3186	3786	Cause	A tool number and a group were specified at the same time.
		Measure	Make sure that the tool and group numbers have not been specified as a feedback destination at the same time.
3187	3787	Cause	System error: Control command
		Measure	If this alarm is issued, it is likely that there may be a problem in the system. Inform FANUC of this alarm number and the contents of the machining program that encountered the alarm.
3188	3788	Cause	A tool number is invalid.
		Measure	Check the tool number entered as a feedback destination.
3189	3789	Cause	A group number is invalid.
		Measure	Check the group number entered as a feedback destination.
3190	3790	Cause	An offset type is invalid.
		Measure	Check the offset type entered as a feedback destination.
3191	3791	Cause	System error: T/M
		Measure	If this alarm is issued, it is likely that there may be a problem in the system. Inform FANUC of this alarm number and the contents of the machining program that encountered the alarm.
3192	3792	Cause	System error: Setting destination
		Measure	Check the setting destination entered as a feedback destination.
3193	3793	Cause	System error: Setting condition
		Measure	Check the setting condition entered as a feedback destination.
3194	3794	Cause	An offset number is invalid.
		Measure	Check the offset number entered as a feedback destination.
3195	3795	Cause	System error: Variable
		Measure	If this alarm is issued, it is likely that there may be a problem in the system. Inform FANUC of this alarm number and the contents of the machining program that encountered the alarm.
3196	3796	Cause	System error: Memory
		Measure	If this alarm is issued, it is likely that there may be a problem in the system. Inform FANUC of this alarm number and the contents of the machining program that encountered the alarm.
3197	3797	Cause	The value set as the tool offset failed to fall in the allowable range.
		Measure	Check the maximum tool wear offset value specified in NC parameter No. 5013.
3198	3798	Cause	If "GROUP NUMBER" is set as the setting destination in inspection after machining, a tool whose life state is "USING" is not found when the results of measurement are fed back.
		Measure	Check if a tool whose state is "USING" is present among the tools that belong to the group number specified as a feedback destination on the life management data screen.

C SETTING BY THE MACHINE TOOL BUILDER

When the set-up guidance functions are used, each machine tool builder needs to perform setting in order to operate the measurement functions. Customization measures for supporting various measurements needs are also available.

Appendix C, “CUSTOMIZATION BY THE MACHINE TOOL BUILDER”, consists of:

C.1 SETTING FOR OPERATING THE SET-UP GUIDANCE FUNCTIONS

When using the measurement functions, each machine tool builder needs to perform setting as described below. This setting is required even when the FANUC standard measurement functions are used.

C.1.1 Setting for Operating Manual Measurement

For manual measurement operation, a PMC program used to start the operation of the macro program for measurement execution needs to be created.

Procedure for executing the macro program for measurement execution

When the [MESURE] soft key is pressed on the manual measurement screen, the macro program for measurement execution is executed for measurement according to the procedure below.

<1> The MANUAL GUIDE system software turns on the user program execution start signal (GST).
<2> After the MEM mode is set, the PMC program turns on the automatic operation start signal.
<3> The macro program for measurement execution set in the parameter indicated below is executed.
<4> Upon completion of program operation, the PMC program turns on the user program execution end signal (GERS).

User program number for measurement execution

Specify a user program (P-CODE macro program) for measurement execution in the following parameter:

12388	Macro program number for measurement execution

(Default value = 3600)

Modification to the PMC program

<1> Execution start processing at user program call time

When the [MESURE] soft key is pressed on the measurement execution screen, the MANUAL GUIDE system software sets bit 0 (hereinafter referred to as "GST") of the R signal specified in parameter No. 12386 to 1 to start the execution of the called program.

GST=1 : Requests the start of execution after switching the mode to the MEM mode.

In response to the request above, the PMC program must switch the mode to the NEM mode, then perform processing for starting machining operation.

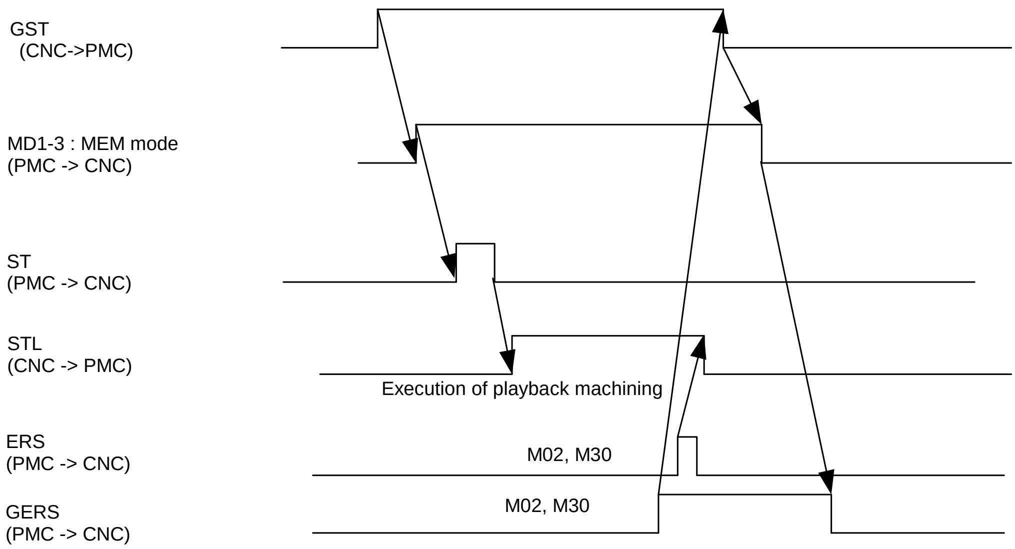
<2> User program execution end signal GERS

When the user program ends with the M02 or M30 command, the PMC program must set bit 7 (hereinafter referred to as "GERS") of the R signal specified in parameter No. 12386 to 1.

GERS=1 : End of user program execution

In response to the request above, the system software sets the GST signal to 0.
After the GST signal is set to 0, the PMC program must switch the mode from the MEMORY mode to the previous mode, then set the GERS signal to 0.

<Timing chart>



Setting for use with a multipath lathe

The parameter below used to set a PMC signal controlled for operating manual measurement is common to all paths.

12386	PMC signal for measurement

Accordingly, the following control is needed with a PMC program:

PMC program modifications

<1> Execution start processing performed when a user program is called

When the [MESURE] soft key is pressed on the measurement execution screen, the MANUAL GUIDE system software sets bit 0 (GST) of the R signal specified in parameter No. 12386 to 1 to start execution of the called program.

GST = 1 : Requests start of execution after switching to the MEM mode.

In response to the request above, the PMC program needs to switch to the MEM mode on the selected path then execute processing for starting machining operation.

<2> User program execution end signal GERS

When a user program ends with an M02 or M30 command, the PMC program needs to set bit 7 (GERS) of the R signal specified in parameter No. 12386 to 1.

GERS = 1 : Ends user program execution.

In response to the request above, the system software sets the GST signal to 0.
After the GST signal is set to 0, the PMC program needs to switch the mode from the MEM mode to the previous mode then set the GERS signal to 0.

C.1.2 Setting for Performing Tool Change from the Tool Measurement Screen for Manual Measurement

To change the tool when the [TL-SEL] soft key is pressed on the tool selection screen, create a P-CODE macro program to be called for tool change.

Tool number

"TOOL NO." entered on the "T-SELECT" screen is stored in the following variable:

#(value of parameter No. 12383 + 0)	Tool number T entered on the screen

Tool change mechanism

When the [TL-SEL] soft key is pressed, the PMC signal for tool change is turned on, and the user program for tool change specified in the following parameter is activated:

12387	**Macro program number for tool selection execution**

(Default value = 3800)

The procedure used until the macro program for tool change is activated after the PMC signal is turned on is the same as for manual measurement. For details, see "Procedure for executing the macro program for measurement execution" described in Section C.1.1.

C.1.3 Support for a Machine with a FANUC Series 16*i*/18*i*-TB for Compound Machining Function

Measurement variable

As variables for measurement, P-CODE macro variables common to turning and milling are used.
When variables numbered #10000 to less than #20000 are used as variables for measurement, set bit 1 (TIVR1) of compile parameter No. 9007 to 1. (When variables numbered #20000 to less than #30000 are used, those variables are common to turning and milling. So, the compile parameter need not be set.)

Auxiliary macro

After measurement execution, an auxiliary macro is used to set the results of measurement as the offset value and workpiece origin offset of the other system. The number of this auxiliary macro is O3650. Accordingly, set 3650 in the compile parameter No. 9039 on the turning and milling side.
If the auxiliary macro is already used, add processing so that O3650 is called from the main macro program.

C.2 OTHER SETTING

C.2.1 User Macro Program Called for Measurement Execution

When a measurement cycle starts or ends, the user P-CODE macros specified in parameter No. 12396 and parameter No. 12397 are called. When the measurement macro called by pressing the [MESURE] key on the manual measurement screen starts or ends, the user macros specified in parameter No. 12394 and parameter No. 12395 are called.
By using these user macro programs, measurement instrument switch ON/OFF control can be automatically exercised at the time of measurement execution.

> **NOTE**
> A user program is called by an M98-based subprogram call.

Referencing a measurement type number

In a user macro program, the measurement type number (screen number) of the calling measurement macro can be referenced. Accordingly, based on this number, the operation in the user macro program can be changed according to the type of measurement.

(1) Variable for storing a measurement type number
For a measurement type number, reference the following variable:

Variable with the variable number set in parameter No.12383 +1

(Example)
When 20300 is set in parameter No. 12383, the variable number to be referenced is #20301.

(2) Measurement type number
A measurement type number indicated below is posted to the user macro program according to the type of measurement.

- For manual measurement
  The table below indicates the relationships between measurement types and numbers.

Type of measurement		No.
Calibration	Touch sensor position measurement	1
	Probe length calibration	2
	Stylus ball diameter calibration	3
	Stylus offsets calibration-A	4
	Stylus offsets calibration-B	5
Tool measurement	Tool measurement	30
Work set	Single surface measurement probe Z-axis	10
	Single surface measurement probe X-axis	110
	Outside diameter work setup	11
	Inside diameter work setup	12
	Outside width work setup	13
	Inside width work setup	14
	C-axis outside width work setup	15
	C-axis inside width work setup	16
Measure	Single surface measurement probe Z-axis	40
	Single surface measurement probe X-axis	140
	Outside diameter work setup	41
	Inside diameter work setup	42
	Outside width work setup	43
	Inside width work setup	44

- For a measurement cycle
  In the case of a measurement cycle, the measurement type number consists of the lower three digits of the four-digit G code of a calling measurement cycle.

  (Example)
  For G2010 rotary tool measurement (tool in the Z-axis direction), the measurement type number is 10.
  For G2143 outside diameter measurement (probe in the X-axis direction), the measurement type number is 143.

Example of user program

The example below exercises control by setting separate sensor preparation signals to ON according to the type of measurement in the user program called at the time of automatic tool measurement execution.

(Example)

```
O9000 /*User program called at the time of automatic tool measurement execution*/
  :
#100=P12383                    /*Read parameter No. 12383*/
  :
/*Check the turning tool measurement cycle*/
IF[#[#100+1] EQ 11 || #[#100+1] EQ 111]THEN
(Set the preparation signal of the sensor for turning tool measurement to ON)
ENDIF
/*Check the rotary tool measurement cycle*/
IF[#[#100+1] EQ 10 || #[#100+1] EQ 110]THEN
(Set the preparation signal of the sensor for rotary tool measurement to ON)
ENDIF
  :
```

Referencing other information items

Additional data set on the screen can be referenced as described below.

- For manual measurement
  Input data is stored in the following variables:

Tool measurement	
#[n+2]	Measurement direction
#[n+3]	Measurement condition

Single surface measurement	
#[n+2]	Measurement direction
#[n+3]	Measurement condition

Outside diameter work setup	
#[n+2]	Measurement direction at each point
#[n+3]	Measurement condition
#[n+4]	Measurement point (1 to 4)
#[n+5]	Spindle orientation enable/disable
#[n+6]	Measurement direction (measurement plane)

Inside diameter work setup	
#[n+2]	Measurement direction at each point
#[n+3]	Measurement condition
#[n+4]	Measurement point (1 to 4)
#[n+5]	Spindle orientation enable/disable
#[n+6]	Measurement direction (measurement plane)

Outside width work setup	
#[n+2]	Measurement direction at each point
#[n+3]	Measurement condition
#[n+4]	Measurement point (1 to 2)

Inside width work setup	
#[n+2]	Measurement direction at each point
#[n+3]	Measurement condition

Inside width work setup	
#[n+4]	Measurement point (1 to 2)

C-axis outside width work setup	
#[n+2]	Measurement direction at each point
#[n+3]	Measurement condition
#[n+4]	Measurement point (1 to 2)

C-axis inside width work setup	
#[n+2]	Measurement direction at each point
#[n+3]	Measurement condition
#[n+4]	Measurement point (1 to 2)

Touch sensor position measurement	
#[n+2]	Measurement direction
#[n+3]	Measurement condition
#[n+4]	Reference tool dimension in the Z direction
#[n+5]	Reference tool dimension in the XY direction

Probe length calibration	
#[n+2]	Measurement direction (= -Z)
#[n+3]	Measurement condition
#[n+4]	Reference surface height

Stylus ball diameter calibration	
#[n+2]	Measurement direction at each point
#[n+3]	Measurement condition
#[n+4]	Measurement point (1 to 4)
#[n+5]	Reference workpiece diameter
#[n+6]	Measurement direction (measurement plane)

Stylus offsets calibration-A	
#[n+2]	Measurement direction at each point
#[n+3]	Measurement condition
#[n+4]	Measurement point (1 to 4)
#[n+5]	Reference workpiece diameter
#[n+6]	Measurement direction (measurement plane)

Stylus offsets calibration-B	
#[n+2]	Measurement direction at each point
#[n+3]	Measurement condition
#[n+4]	Measurement point (1 to 4)
#[n+5]	Reference workpiece diameter
#[n+6]	Center coordinate first axis
#[n+7]	Center coordinate second axis
#[n+8]	Measurement direction (measurement plane)

* "n" in the tables above represents the value set in parameter No. 12383.

* The items above can assume the following values:

Setting item	Data
Measurement direction	+X:1,-X:2,+Y:3,-Y:4,+Z:5,-Z:6,+C:7,-C:8
Measurement condition	Condition 1:1, Condition 2:2, Condition 3:3, Condition 4:4, Condition 5:5, Condition 6:6

Setting item	Data
Measurement point	Measurement point 1:1, Measurement point 2:2, Measurement point 3:3, Measurement 4:4
Spindle orientation	Valid:1, Invalid:-1
Measurement direction (measurement plane)	X-Y plane:1, Y-Z plane:2

- For a measurement cycle

  (FS16*i*-B,FS0*i*-C)

  The value of the argument of a four-digit G block can be directly referenced by specifying the argument by a macro call.

  (FS30*i*-A,FS30*i*-B, FS0*i*-F,FS0*i*-D)

  - When G code system switch function is not effective

    The value of the argument of a four-digit G block can be directly referenced by specifying the argument by a macro call.

  - When G code system switch function is effective

    When G code system switch function is effective, the variable number to refer to the argument at the measurement cycle by the user macro called at the measurement cycle can be switched according to the following parameters.

	#7	#6	#5	#4	#3	#2	#1	#0
27223					OFS			

OFS In the user macro called at the measurement cycle, the variable number to refer to the argument at the measurement cycle is converted.

0 : is not converted

1 : is converted.

(It converts it into the variable number of the argument for M offset of the FS18i-TB compound machine.)

(Specification of variable number to refer to argument)

Argu-ment	Parameter No.27223#3 (OFS)									
	0					1				
	Offset argument type					Offset argument type				
	A	B	C	D	E	A	B	C	D	E
W	#23	#23	#23	#23	#23	#21	#21	#21	#21	#21
B	#2	-	-	#2	-	#1	-	-	#1	-
I	#4	#4	#4	#4	-	#5	#5	#1	#5	-
S	#19	#19	#19	#19	#19	#6	#6	#6	#6	#6
Y	#25	#25	#25	#25	#25	#8	#8	#8	#8	#8
J	-	-	#5	-	-	-	-	#2	-	-
T	-	-	-	#20	-	-	-	-	#3	-
X	-	-	-	#24	#24	-	-	-	#26	#4
Z	-	-	-	-	#26	-	-	-	-	#5
P	#16	#16	#16	#16	#16	#16	#16	#16	#16	#16
Q	#17	#17	#17	#17	#17	#17	#17	#17	#17	#17
D	-	#7	#7	#7	#7	-	#7	#7	#7	#7
C	#3	#3	-	-	#3	#3	#3	-	-	#3
F	#9	#9	#9	#9	#9	#9	#9	#9	#9	#9
H	#11	#11	#11	#11	#11	#11	#11	#11	#11	#11
V	#22	#22	#22	#22	#22	#22	#22	#22	#22	#22
A	-	#1	-	-	#1	-	#1	-	-	#1
L	#12	#12	#12	#12	#12	#12	#12	#12	#12	#12
R	-	#18	#18	#18	#18	-	#18	#18	#18	#18
N	#14	-	#14	#14	-	#14	-	#14	#14	-
T	#20	-	-	-	-	#20	-	-	-	-
M	-	-	#13	#13	-	-	-	#13	#13	-

(Explanation of offset argument type)

The argument for the offset at the measurement cycle differs according to the measurement cycle, and is classified into the following five patterns (A-E).

Offset argument type	Address of argument used at measurement cycle
A	W、B、I、S、Y
B	W、I、S、Y
C	W、I、S、Y、J
D	W、B、I、S、Y、T、X
E	W、S、Y、X、Z

(Correspondence table of measurement cycle and offset argument type)

Kind	Measurement cycle	Offset argument type
Tool measure	G2010 : Milling tool measure (Z axis)	A
	G2110 : Milling tool measure (X axis)	A
	G2012 : Milling tool measure (Z axis – non touch)	A
	G2112 : Turning tool measure (Z axis– non touch)	A
Work set	G2073 : Outside diameter work-set (Z axis)	C
	G2074 : Inside diameter work-set (Z axis)	C
	G2173 : Outside diameter work-set (X axis)	C
	G2174 : Inside diameter work-set (X axis)	C
	G2022 : End-face work-set Z axis direct. (Z axis)	B
	G2020 : End-face work-set X axis direct. (Z axis)	B
	G2021 : End-face work-set Y axis direct. (Z axis)	B
	G2023 : Outside diameter work-set (Z axis)	C
	G2024 : Inside diameter work-set	C
	G2025 : Outside width work-set (Z axis)	B
	G2026 : Inside width work-set (Z axis)	B
	G2031 : C axis outside width work-set (Z axis)	B
	G2032 : C axis inside width work-set (Z axis)	B
	G2122 : End-face work-set Z-axis direct. (X axis)	B
	G2120 : End-face work-set X-axis direct. (X axis)	B
	G2121 : End-face work-set Y-axis direct. (X axis)	B
	G2123 : Outside diameter work-set (X axis)	C
	G2124 : Inside diameter work-set (X axis)	C
	G2125 : Outside width work-set (X axis)	B
	G2126 : Inside width work-set (X axis)	B
	G2131 : C-axis Outside width work-set (X axis)	B
	G2132 : C-axis inside width work-set (X axis)	B
Measure	G2083 : Outside diameter measure (Z axis)	D
	G2084 : Inside diameter measure (Z axis)	D
	G2042 : End-face measure Z-axis direct. (Z axis)	D
	G2040 : End-face measure X-axis direct. (Z axis)	D
	G2041 : End-face measure Y-axis direct. (Z axis)	D
	G2043 : Outside diameter measure (Z axis)	D
	G2044 : Inside diameter measure (Z axis)	D
	G2045 : Outside width measure (Z axis)	D
	G2046 : Inside width measure (Z axis)	D
	G2053 : Outside diameter measure (work rot. - Z axis)	D
	G2054 : Inside diameter measure (work rot. - Z axis)	D
	G2183 : Outside diameter measure (X axis)	D
	G2184 : Inside diameter measure (X axis)	D
	G2142 : End-face measure Z-axis direct. (X axis)	D
	G2140 : End-face measure X-axis direct. (X axis)	D
	G2141 : End-face measure Y-axis direct. (X axis)	D
	G2143 : Outside diameter measure (Z axis)	D
	G2144 : Inside diameter measure (Z axis)	D
	G2145 : Outside width measure (Z axis)	D
	G2146 : Inside width measure (Z axis)	D
	G2153 : Outside diameter measure (work rot. - X axis)	D
	G2154 : Inside diameter measure (work rot.- X axis)	D
Setting Error amount	G2029 : Angle of slanted work-piece work-set (Z axis)	E
	G2129 : Angle of slanted work-piece work-set (X axis)	E

C.2.2 Recalculation Processing Using a Measurement Result List

In manual measurement and automatic measurement using the set-up guidance functions, measurement results are stored in macro variables for a measurement result list. A calculation using this measurement result data can be made with a custom macro program or P-CODE macro program.
This calculation capability can be used when multiple measurement cycles are involved, and feedback operation is not performed in each measurement but feedback operation is performed by recalculating feedback values finally based on the results of individual measurements.

> **NOTE**
> This function cannot be used with FANUC Series 0*i*-F/0*i*-D and Series 30*i*/31*i*/32*i*-A.

Subprogram for acquiring data from the measurement result list

To acquire measurement results from the measurement result list, call the following P-CODE macro program:
O3890: Subprogram for acquiring measurement results from the measurement result list

Call format: G65P3890 Q[measurement-result-number]
Input: Number of a measurement result on the measurement result list (The number "1" is assigned to the latest measurement result.)
Output: Measurement result data (P-CODE macro variable)

(Output data)

Variable number	Description	Meaning of value
#[Parameter No.12383+50]	Measurement type	Measurement type number
#[Parameter No.12383+51]	Distinction between manual and automatic	1:Manual, 2:Automatic
#[Parameter No.12383+52]	Date	
#[Parameter No.12383+53]	Time	
#[Parameter No.12383+54]	Decision result (OK/NG/FB/-)	1:No decision, 1:NG, 3:OK, 4:Feedback
#[Parameter No.12383+55]	Setting destination	Described later
#[Parameter No.12383+56]	Setting destination details	Described later
#[Parameter No.12383+57]	Setting destination compensation type	Described later
#[Parameter No.12383+58]	Setting destination offset number/ measurement condition group number	Described later
#[Parameter No.12383+59]	Measurement result X	
#[Parameter No.12383+60]	Measurement result Y	
#[Parameter No.12383+61]	Measurement result Z	
#[Parameter No.12383+62]	Measurement result C	
#[Parameter No.12383+63]	Measurement result Diameter, width	
#[Parameter No.12383+66]	Target value X	
#[Parameter No.12383+67]	Target value Y	
#[Parameter No.12383+68]	Target value Z	
#[Parameter No.12383+69]	Target value C	
#[Parameter No.12383+70]	Target value Diameter, width	
#[Parameter No.12383+73]	Setting Workpiece coordinate system X, touch sensor position X	
#[Parameter No.12383+74]	Setting Workpiece coordinate system Y, touch sensor position Y	
#[Parameter No.12383+75]	Setting Workpiece coordinate system Z, touch sensor position Z	
#[Parameter No.12383+76]	Setting Workpiece coordinate system C	

Variable number	Description	Meaning of value
#[Parameter No.12383+77]	Setting Offset feedback value	
#[Parameter No.12383+82]	OK range on the T side	The latest data is acquired at all times.
#[Parameter No.12383+83]	Feedback range on the T side	The latest data is acquired at all times.
#[Parameter No.12383+84]	OK range on the M side	The latest data is acquired at all times.
#[Parameter No.12383+85]	Feedback range on the M side	The latest data is acquired at all times.

Setting destination	Setting destination details	Setting destination compensation type	Setting destination compensation type/ measurement condition group number
1 = T series – Tool offset	1 = X axis 2 = Z axis 3 = Radius 4 = Y axis 5 = B axis	1 = Geometry 2 = Wear	Offset number
2 = M series – Tool offset	6 = Tool length compensation 7 = Cutter compensation	1 = Geometry 2 = Wear	Offset number
3 = T series – Workpiece coordinate system	8 = Workpiece coordinate system 9 = Workpiece coordinate system set number addition	0	Offset number
4 = M series – Workpiece coordinate system	8 = Workpiece coordinate system 9 = Workpiece coordinate system set number addition	0	Offset number
5 = Calibration	0	0	Measurement condition group number

Sample program

The sample program below, O2099, measures the centers of two circular pockets and finds the distance between the centers.

```
O2099(SAMPLE)
G2024Q1.D80.H0.V0.L-20.R30.F50.P4.M2.
        Circle centering measurement 1
G2024Q1.D80.H100.V100.L-20.R30.F50.P4.M2.
        Circle centering measurement 2
(CENTER 1)
G110Q2.
        Acquire measurement results of circle centering measurement 1
#131=#109       Center X coordinate obtained by measurement
#132=#110       Center Y coordinate obtained by measurement
(CENTER 2)
G110Q1.
        Acquire measurement results of circle centering measurement 2
#133=#109       Center X coordinate obtained by measurement
#134=#110       Center Y coordinate obtained by measurement
```

```
(CALCULATE)
#135=ABS[#133-#131]
#136=ABS[#134-#132]
#137=SQRT[#135*#135+#136*#136]
    Calculate distance between centers
M02
%
```

(Additional information)

User macro program

This sample program calls a user macro program with the G code (G110) to acquire measurement results.

Code of the user macro program

```
O9010    G65P3890 Q[#17]
#1 = P12383
#99100 = #[#1+50]        /* Measure ID */
#99101 = #[#1+51]        /* Manual / Auto */
#99102 = #[#1+52]        /* Date */
#99103 = #[#1+53]        /* Time */
#99104 = #[#1+54]        /* Judgement Code */
#99105 = #[#1+55]        /* Set Data Type */
#99106 = #[#1+56]        /* Set Data Kind */
#99107 = #[#1+57]        /* Set Offset Type */
#99108 = #[#1+58]        /* Set Data Number */
#99109 = #[#1+59]        /* Result X */
#99110 = #[#1+60]        /* Result Y */
#99111 = #[#1+61]        /* Result Z */
#99112 = #[#1+62]        /* Result C */
#99113 = #[#1+63]        /* Result D */
#99114 = #[#1+66]        /* Target X */
#99115 = #[#1+67]        /* Target Y */
#99116 = #[#1+68]        /* Target Z */
#99117 = #[#1+69]        /* Target C */
#99118 = #[#1+70]        /* Target D */
#99119 = #[#1+73]        /* FeedBack X */
#99120 = #[#1+74]        /* FeedBack Y */
#99121 = #[#1+75]        /* FeedBack Z */
#99122 = #[#1+76]        /* FeedBack C */
#99123 = #[#1+77]        /* FeedBack Offset */
m99
```

C.2.3 Extension of the Number of Workpiece Measurement Condition Groups

Up to six measurement condition groups for centering/post-machining inspection in workpiece measurement can be set as standard. This number of groups can be extended to 10.

> ⚠ **CAUTION**
> To enable input of up to ten measurement condition groups, the settings of parameter No. 12381 through No. 12385 for defining the macro variable areas used with the measurement functions need to be modified.

Parameters for variable definition

To enable input of up to ten measurement condition groups, the settings of parameters for defining the macro variable areas used with the measurement functions need to be modified.

Parameter No.	Meaning
12381	Start number of the macro variable area for setting and preserving measurement conditions
12382	Start number of the macro variable area for setting and preserving calibration data
12383	Variable area used for measurement function execution
12384	Start number of the macro variable area for preserving the result of measurement
12385	Number of macro variables that can be used to preserve the result of measurement

Set the parameters as indicated below.
The table below indicates the number of macro variables used with each function.

Function	Classification	Number of variables used (per group)	Number of groups
Variables for measurement conditions	Operation setting	7	-
	Measurement condition for tool measurement	11	0 to 4
	Measurement condition for centering/post-machining inspection	21	0 to 10
	Customization item	0 to 20	-
Variables for calibration data	Operation setting	7	-
	Touch sensor position	36(18) (Note 1)	0 to 4
	Probe form	5	0 to 10
Macro variable for measurement function execution		200	-
Preservation of the result of measurement		Arbitrary (Note 2)	-

NOTE

1. If 0 (= No) is set in "WHETHER USE OF TOUCH SENSOR COMPENSATE" on the "SETTING" screen of calibration data, the number of variables used is 18.
2. An arbitrary number can be set as the number of variables for preserving the result of measurement. Usually, specify a value obtained by subtracting the number of "variables for measurement conditions," the number of "variables for calibration data," and the number of "macro variables for measurement function execution" from the number of macro variables in the areas usable as measurement variables.

An example of calculating the number of variables used and parameter setting under the following condition is given below:

Number of measurement conditions for tool measurement: 4
Number of measurement condition groups for centering/post-machining inspection: 10
"WHETHER USE OF TOUCH SENSOR COMPENSATE": Set to 1 (= Yes)
Number of customization items: 20

<1> Number of variables used

Variables for measurement conditions
= 7 (for operation setting) + 11 × 4 (for tool measurement) + 21 × 10 (for centering/post-machining inspection) + 20 (for customization items)
= 281

Variables for calibration data
= 7 (for operation setting) + 36 × 4 (for tool measurement) + 5 × 10 (for centering/post-machining inspection)
= 201

<2> Parameter setting

When P-CODE macro variable numbers in the ten thousands are used as variables for measurement, set the following:

No.12381 10000
No.12382 10290
No.12383 10500
No.12384 10700
No.12385 499 (when 12,000 variables can be used from variable numbers in the ten thousands)

> ⚠ **CAUTION**
> 1 When the parameter for defining the variable area for measurement is modified, or the number of measurement condition groups or calibration data groups is modified, macro variable numbers for preserving measurement conditions and calibration data different from the previous numbers are referenced, so that no correct measurement can be made. Be sure to check and set measurement conditions and calibration data on the respective setting screens before making a measurement.
> 2 Set the same value as the number of measurement condition groups and the number of calibration data groups.
> 3 Before modifying the parameter for defining the measurement variable area, back up the measurement condition data and calibration data to a memory card.

Customization definition file modification

To enable up to ten measurement condition groups to be input on the measurement cycle input screen, the machine tool builder needs to make the following modification to the customization definition file:

File to be modified
Modify the cycle input definition file dlgmkupu.txt.

Modification
By using the cycle input screen definition file editing tool ScreenDesigner.exe, change the maximum allowable input value for "MEASURE CONDITION" from 6 to 10.

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REVISION RECORD

Edition	Date	Contents
08	Jul., 2015	• Addition of explanation for Series 0*i*-F
07	Dec., 2013	• Addition of measurement cycle of points and angle • Addition of measurement cycle for rotary axis position calibration in 5-axis machine • Addition of tilted working plane indexing command by measuring • Addition of set-up guidance functions in tilted working plane command mode • Addition of description about parameter No.9051-9054 • Addition of description about tool offset memory • Correction of errors
06	Mar., 2012	• Addition of screen and icon • Correction of errors
05	Dec., 2011	• Addition of workpiece setting error measurement • Addition of tool Length Compensation in Manual Measurement • Addition of tool measurement with multi-step skip signals • Correction of errors
04	May, 2008	• Addition of explanation for Series 0*i*-D
03	Jul., 2007	• Addition of support for measurements of work rotation type· Reflection of supported machine configuration • Addition of measurement of the outside/inside of a corner • Addition of measurement of the angle of a slanted workpiece • Addition of three-point measurement of an arbitrary angle • Correction of clerical errors and so forth
02	Jan., 2003	• Improvements of the measuring movement of the measurement cycle are applied. • Support for inch/mm switching is added. • Contents of customization in the machine tool builder are added. • Correction of errors
01	Aug., 2002	

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